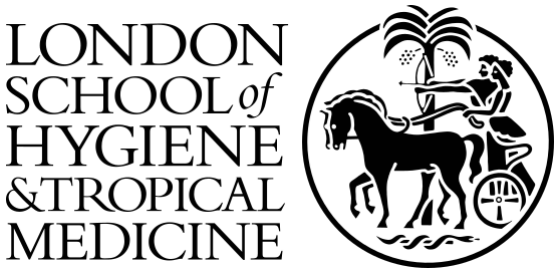

EPIDEMIOLOGY OF ALCOHOL USE AND ALCOHOL USE DISORDERS (AUD) AMONG YOUNG PEOPLE IN NORTHERN TANZANIA

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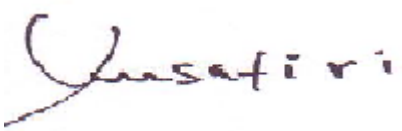
Funded by STRIVE RPC, an international research consortium funded by the UK Department for International Development (DFID) to investigate structural drivers of HIV.

I, Joel Msafiri Francis, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.



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List of Abbreviations

AUD	Alcohol Use Disorders
AUDIT	Alcohol Use Disorders Identification Test
AUROC	Area Under Receiver Operating Characteristics
CAGE	Cutting down, Annoyance by criticism, Guilty feeling, and Eye-openers - screening test for problem drinking and potential alcohol problems
CDT	Carbohydrate-Deficient Transferrin
CI	Confidence Interval
DALY	Disability-Adjusted Life Year
DFID	UK Department for International Development
DSM IV	Diagnostic and Statistical Manual of Mental Disorders
GGT	Gamma-Glutamyl Transferase
HIV	Human Immunodeficiency Virus
IQR	Interquartile range
MINI	Mini International Neuropsychiatric Interview questionnaire
MITU	Mwanza Intervention Trials Unit
NIMR	National Institute for Medical Research
PEth	Alcohol biomarker Phosphatidylethanol
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QATSO	Quality Assessment Tool for Systematic reviews of Observational studies
SSA	Sub Saharan Africa
STIs	Sexually Transmitted Infections
STRIVE RPC	acronym of a Research Programme Consortium (RPC) to investigate Structural Drivers of HIV Infection
STROBE	Strengthening the Reporting of Observational studies in Epidemiology
TB	Tuberculosis
TFLB	Time Line Follow Back calendar
WHO	World Health Organisation

Abstract

Excessive alcohol use is a significant public health problem globally. Alcohol use typically begins in adolescence or early adult life, and effective prevention strategies focused on this age group are needed to avoid initiation of harmful drinking.

The aims of this PhD are to understand the epidemiology of alcohol use and alcohol use disorders (AUD) in East Africa, to validate self-reported alcohol use among young people in Tanzania, and to use the findings to recommend strategies for the prevention or reduction of harmful alcohol use among young people. Specific objectives include (1) to systematically review the evidence on alcohol use among young people in eastern Africa; (2) to estimate the prevalence of alcohol use, AUD and associated risk factors among different groups of young-people in northern Tanzania; (3) to assess the validity of self-reported alcohol use against the blood biomarker phosphatidylethanol (PEth); and (4) to assess the validity of the Mini International Neuropsychiatric Interview questionnaire (MINI) for the diagnosis of alcohol dependence against PEth, in Mwanza (northern Tanzania).

The main findings are a high prevalence of reported alcohol use among diverse groups of young people in eastern Africa, especially among university students and sex workers, but that few studies used standardised alcohol screening questionnaires. In our survey of almost 2000 young people in northern Tanzania, the prevalence of reported alcohol use was higher among males (20-45% for current use) than females (12-47% for current use). Alcohol use was also associated with being in a relationship, greater disposable income, and a higher number of sexual partners.

There were significant positive correlations between reported total alcohol intake and PEth concentration in males (Spearman correlation (r_s)=0.65 among college students and r_s=0.57 among casual labourers; p<0.001). Self-reported alcohol use in the past month was also a sensitive marker of having a positive PEth result (overall sensitivity 89%, 95%CI 81-94%), and was similar in all groups. The MINI dependence criteria (positive responses to ≥3 questions) were met by 79/202 (39%) casual workers and college students. The high prevalence was mainly due to two non-specific questions (on tolerance and compulsion to drink). Both sensitivity and specificity of the MINI were low when compared to PEth, raising questions about the validity of the tool for this population.

This thesis finds that alcohol use is a significant problem among young people in northern Tanzania, and the Timeline Followback calendar (TLFB) and Alcohol Use Disorders Identification Test (AUDIT) are sensitive measures of alcohol use. Most affected groups are college students and casual labourers. These two groups need urgent interventions addressing both individual and societal risks to reduce hazardous/harmful alcohol use.

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Chapter 1. Introduction and background

The first aim of my PhD is to study the epidemiology of alcohol use and alcohol use disorders (AUD) among young people in East Africa, specifically in northern Tanzania. Further, because screening tools to determine alcohol use and AUD are based on self-report and have not been validated among young people in Africa, the second aim is to validate the most frequently used of these tools in a young study population from Tanzania. In this chapter, I described the background and context of alcohol use problems among young people in Tanzania.

Alcohol use as a global health problem

Excessive alcohol use is a global public health problem accounting for about 6% of mortality and 5% of disability adjusted life years (DALYs) lost worldwide [1]. The World Health Organization (WHO) estimates that, globally, about 53% of people aged 15 years and above have ever used alcohol and 39% used it in the last year [1]. Within Africa, an estimated 43% of those aged 15 years or above have ever used alcohol and 30% used it in the last year. The reported prevalence of alcohol use disorders (AUD) (defined by an Alcohol Use Disorders Identification Test (AUDIT) score of ≥8) [2] is estimated at 4% globally and 3% in Africa, and is generally more prevalent among men than women [1].

Data from industrialized countries show that excessive alcohol use that may lead to AUD often begins at a young age [3-5]. In 2012, according to WHO, 46% of the world's adolescents aged 15-19 years reported having ever used alcohol, and 34% had used it in the last year. In Africa, these estimates were 41% and 29% respectively [1]. The prevalence of heavy episodic drinking[1] [1] in adolescents was 8% globally and 6% in Africa, and higher among adolescents than adults [1].

[1] Intake of 6 or more standard drinks in a drinking occasion

Alcohol use and AUD are associated with increased risks of infectious diseases such as HIV/AIDS and sexually transmitted infections [1,6-33], TB and pneumonia [34,35], and chronic non-communicable diseases such as hypertension and its complications such as stroke and atrial fibrillations [36-39]. AUD may also interfere with the treatment of chronic diseases such as diabetes and HIV/AIDS due to poor treatment adherence [40,41]. Furthermore, alcohol use and AUD are associated with intentional and unintentional injuries, domestic violence, unemployment and decreased work productivity [42-46].

Alcohol use as a public health problem among young people

During puberty, the processes leading to brain maturation are associated with a longing for independence, increased peer interaction, proclivity and modified response inhibition, reward seeking, and emotional regulations [47-49]. Because of these, adolescents and young adults tend to experiment, and the intake of excessive amounts of alcohol is one of the frequent consequences [3-5]. Alcohol use among young people is also influenced by culture [50], however young people may initiate alcohol use for a variety of other reasons including a desire to better cope with stressful situations, social motives and positive enhancements experienced through alcohol [51,52]. Previous studies from Europe, America and some settings in sub-Saharan Africa (SSA) showed that risk factors predisposing young people to excessive alcohol use include male gender, peer pressure, family history of alcohol abuse, unstable employment, economic uncertainties, poor social and coping skills, increased alcohol availability, and positive expectations regarding alcohol use [51,53-56]. In addition, other studies identified religion, personal income, education level, older sexual partners, exposure to stress and having relatives and friends who drink alcohol as factors associated with alcohol use among young people [51,52,57-63].

Alcohol use among young people in Africa

In Africa, adolescents and young adults have traditionally grown up within communities characterized by strong social control that guided them with respect to risky behaviours of various kinds. Over recent decades, this traditional pattern of life has changed; and young people are increasingly affected by new social norms that result from population mobility, migration and an intensive exchange of communication between urban and rural populations. In addition, radio, television and other forms of information technology have reached almost all parts of the continent, including remote rural communities. All of these developments contribute to changes in beliefs and life styles particularly among young people [64]. In recent years, alcohol advertisements have become widespread in SSA and in other regions of the world. Most advertisements display alcohol use as modern and associate it with occupational and sexual achievements [65-67].

Few data exist on the amount and the harmful consequences of alcohol use among young people in Africa, and even fewer on the structural and individual factors that lead to the uptake and persistence of harmful alcohol use in this group. A better understanding of the epidemiology of alcohol use among young people is required to facilitate the design of effective interventions.

Screening tools for alcohol use disorders

Various screening instruments have been developed to measure alcohol intake and diagnose AUD. The most frequently used screening tool is the Alcohol Use Disorder Identification Test (AUDIT) [68-73]. The quantity and frequency of alcohol intake is based on self-reports involving calendar methods, particularly the alcohol Timeline Follow Back calendar (TLFB) [74-76]. The Mini International Neuropsychiatric Interview questionnaire (MINI), based on DSM IV/ICD 10, is a recommended tool for clinical assessment of

psychiatric conditions including AUD, however, this tool has to be administered by trained medical personnel; MINI is a gold standard for the diagnosis of AUD in the context of clinical psychiatric assessments [70,77]. Other tools include AUDIT-C[2], the Single Alcohol Use Screening Question (SASQ)[3], CAGE[4] and FAST[5] [78-80]. Most of these tools have been developed, validated, and are widely used in developed world settings.

The Alcohol Use Disorders Identification Test (AUDIT), a self-report alcohol screening tool for excessive drinking developed by WHO, has been used in both high and low income countries and recommended for use in primary care settings among adults [70,72,81]. A shorter version of AUDIT, the AUDIT-C that includes the first three questions of AUDIT on alcohol consumption is effective in AUD screening [78]. The Time Line Follow Back (TLFB) calendar method that also relies on self-reported information (in terms of quantity and frequency) has been mainly applied in high-income settings [74-76]. Because AUDIT and TLFB have been shown to be useful tools for alcohol screening in young people in some settings [68,71,76], they are potentially useful to inform alcohol interventions among young people in Africa as well; however, they have not yet been validated among such populations**.**

Biomarkers for alcohol intake

Self-reported alcohol use may be subject to errors for example due to social desirability bias or the influence of local perceptions on alcohol. A more objective assessment of alcohol use and AUD is required. The application of alcohol biomarkers for this purpose has been suggested [82]. Unfortunately, these are expensive and cannot easily be applied

[2] First three AUDIT questions on alcohol consumption

[3] How often have you had 6 or more units if female, or 8 or more if male, on a single occasion in the last year?

[4] comprised of four questions referring to the concepts of ''Cutting down, being Annoyed, feeling Guilty and needing an Eye opener

[5] Four AUDIT questions

routinely in the context of alcohol intervention programmes in Africa. However, they can be used in research in Africa to validate self-report based screening tools [83-85]. A range of alcohol biomarkers exists including Phosphatidylethanol (PEth), Carbohydrate Transferrin Test (CDT), and Gamma Glutamyl Transferase test (GGT) [86-88]. PEth is a direct alcohol metabolite in the blood, for the detection of social to heavy alcohol use in the past 28 days and has high sensitivity (98%) and specificity (100%) as an alcohol biomarker compared to actual amount of alcohol use. Unlike other indirect biomarkers (CDT and GGT), PEth allows quantitative measurements of alcohol intake and is able to discriminate between moderate ('social') and heavy drinkers, and has therefore been recommended for detecting hazardous alcohol use [89-91]. It has been used among adult populations globally, including in Sub Saharan Africa, to examine self-reported hazardous and harmful alcohol use [85,92,93]. PEth is very specific and sensitive for heavy and chronic alcohol intake, however it is difficult to establish the PEth cut off for heavy alcohol intake due to inter-individual metabolism rates for PEth [94]. For this PhD work, we utilized the harmonized PEth cut off (≥30 μmol/L) for heavy alcohol use for Swedish population [95].

To meet the second aim of this thesis on alcohol use and AUD among young people in Tanzania, PEth was applied to validate self-reported alcohol use and selected screening tools recommended for the detection AUD.

Outline of the thesis

This PhD thesis is comprised of eight chapters. Chapter 1 gives background information, chapter 2 provides an overview of the study designs and data collection approaches. Chapters 3 to 6 comprise research papers of findings from the PhD sub studies. Chapter

7 gives a summary of the findings from the various studies and chapter 8 summarizes the conclusion and recommendations.

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Chapter 2. Methods

This chapter provides an overview of the study designs and data collection approaches for the aims of the PhD and the longer-term goal identifying groups of young people in Africa who may be in need of targeted alcohol interventions, and to provide information required to design such interventions. I designed the three studies, recruited and trained fieldwork staff, oversaw data collection procedures, performed data quality checks, analysed the data and wrote the first version of all manuscripts. I revised the manuscript based on comments from supervisors and co-authors.

Three studies were conducted to address the following five specific objectives of the PhD:

1. To systematically review the prevalence of alcohol use and AUD among young people (aged 15-24 years) in eastern Africa and determine the extent to which international standardized alcohol-screening tools have been applied (**Study 1**).
2. To determine the epidemiology of alcohol use and alcohol use disorders and associated risk factors among young people (aged 15-24 years) in northern Tanzania (**Study 2**).
3. To validate self-reported alcohol use and the AUDIT and TLFB tools among young people (aged 18-24 years) from Mwanza, Tanzania against the blood biomarker Phosphatidyethanol(PEth) as gold standard (**Study 3**).
4. To validate the alcohol dependence section of the MINI questionnaire against PEth among young people (aged 18-24 years) from Mwanza, Tanzania. (**Study 3**).
5. To make recommendations on potential groups of young people in urgent need of alcohol interventions and on the design of such interventions (**Studies 1-3**).

The three studies are described briefly below, and in detail in subsequent specific chapters.

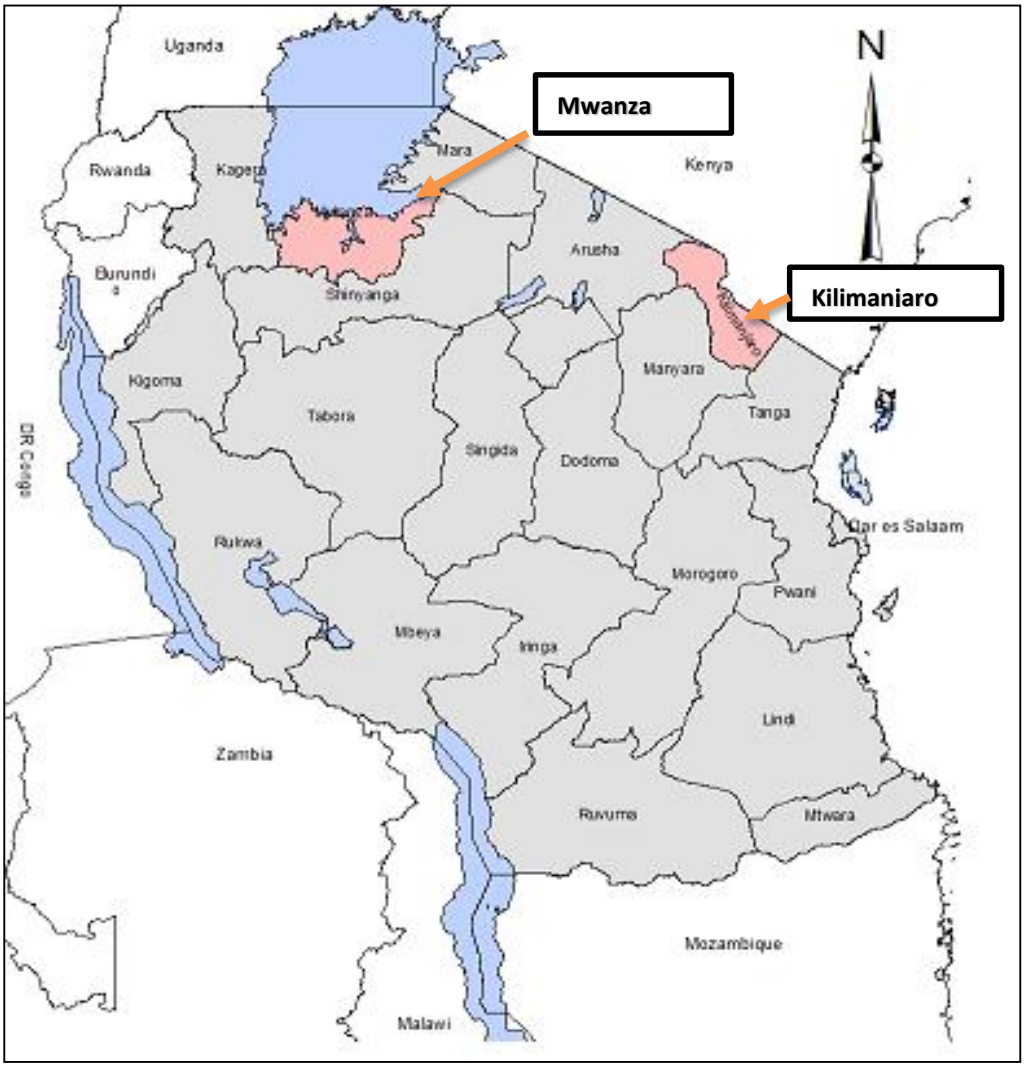
Study 1-A systematic review and meta-analysis of published studies of alcohol use among young people (age 15–24 years) in eastern Africa to i) estimate the prevalence of alcohol use and ii) determine the extent to which standardised screening questionnaires have been used in this region. Five databases (MEDLINE, EMBASE, Global Health, Africa-wide, and PsycINFO) were searched for publications until 30th June 2013 (*see detailed search strategy in the appendix 1)*. Results were summarised using the guidelines on preferred reporting items for systematic reviews and meta-analyses (PRISMA) [1] and on quality assessment using the modified quality assessment tool for systematic reviews of observational studies (QATSO) [2].

Study 2- A cross-sectional survey among 1954 young people aged 15-24 years from 4 groups (secondary school students, college/university students, employees of local industries and casual labourers). We conducted the survey in Mwanza and Kilimanjaro regions of northern Tanzania (Figure1). We selected these regions because they represent different cultural and socio-economic backgrounds providing an opportunity to examine alcohol drinking patterns and risk factors in diverse study populations. These two regions are inhabited by diverse ethnic groups in urban settings but in the rural areas in Kilimanjaro region the predominant ethnic group is Chagga and in Mwanza the Sukuma tribe. These two groups have different alcohol drinking norms whereby norms about alcohol use among young people are more permissive in the Chagga culture than among the Sukuma population. In addition, the National Institute for Medical Research (NIMR) has a research centre in Mwanza and has strong collaborative links with research partners in Kilimanjaro. The estimated total population is about 3.7 million people in

Mwanza region and 1.7 million in Kilimanjaro region. Within the selected regions, we selected two urban districts (Mwanza city and Moshi town) and randomly selected two rural districts (Sengerema district in Mwanza region and Moshi rural district in Kilimanjaro region) out of six districts in each region.

The study population comprised of individuals aged 15-24 years old. The study aimed to enrol male and female young people in approximately equal numbers. In each district, we targeted four groups of young people: (i) secondary school students, (ii) college and university students, (iii) young employees of local industries and (iv) unemployed out-of-school youth. Employed young people were selected from soft drink plants located in Mwanza city and Moshi town, sugar and coffee plantations and factories from rural parts of Kilimanjaro, and ginneries and oil mills from rural parts of Mwanza regions and other local industries when necessary. Because it was difficult to identify members of unemployed out-of-school youth, we included young people with occasional casual work as a proxy for this population. These were identified from construction sites, car garages or from seasonal farm work in rural areas. In Mwanza region, participants from local industries were recruited from the two urban and three rural districts due to due to a smaller than expected number of participants in the selected rural district.

Figure 1: Map showing study areas



|------| 100 km

Sampling strategy and eligibility criteria: Eligible study participants were aged 15-24 years. A multistage stratified random sampling strategy was used to identify participants who were enrolled if they provided written informed consent or assent. Subjects who were under the influence of alcohol at the time of the interviews were given another date for the interviews.

Prior to data collection I recruited 10 research assistants, trained them on data collection procedures and they participated in the piloting of the Swahili translated data collection

tools. I assessed the performance of the research assistants and discontinued those performing poorly. Under my supervision, trained research assistants identified suitable locations for interviews with each study group. They provided information about the study to prospective study participants at their schools, colleges and work places. For secondary students, in day school, we provided study information sheets to share with their parents/guardians. We requested parents/guardians to contact the school authorities or the principal investigator if they decided to object against their children's participation. We recruited study participants after obtaining individual informed assent (for those aged 15-17 years) and consent (for those aged 18 years and above). Participants were interviewed using face-to-face administered structured questionnaires. I assessed the completed questionnaires at the end of each data collection day for completeness. Completed questionnaires were then stored in a secure container until hand-over to the data manager. The data manager generated queries, handed them to me and I resolved the queries with the data collection team accordingly. The questionnaire is included in *appendix 2*. Data were collected on socio-demographic characteristics, initiation of alcohol use, types and quantity of alcohol taken, and circumstances under which alcohol was used. Information about alcohol use was collected using AUDIT. We also collected information about sexual behaviour, history of sexual risk taking under the influence of alcohol, history of STIs, and experience of adverse effects of alcohol use on school or work performance, and on smoking and use of illicit drugs.

Since young people's drinking patterns are variable and may be subject to recall bias, we used the alcohol timeline follow-back (TLFB) method to assess alcohol use at different days of the month. This included a sixty days calendar based on which we requested young people participating in this study to report their past intake of alcohol related to

special occasions, as well as their daily intake. We used a pictorial display of different types of drinks to assess the number of standard alcohol drinks consumed *(appendix 3).*

Study 3- A cross sectional study to validate self-reported alcohol use by TLFB and AUDIT and the diagnosis of possible alcohol dependence by MINI (DSM IV) against the biomarker Phophatidylethanol (PEth) among young adults aged 18 – 24 years in Mwanza, Tanzania. The 3 tools translated into Swahili language were applied among 103 male casual labourers and 99 male and female college students who reported using alcohol during the past year. This study was implemented by a team of four research assistants (2 lay interviewers and 2 medical officers). Under my supervision, the lay interviewers administered the TLFB and AUDIT whereas the medical officers administered the MINI and the phlebotomy. I performed daily data quality checks (completeness of the questionnaires) and resolved additional queries identified by the data manager.

Due to lack of capacity to perform PEth assays locally, I approached Prof Anders Helander of the Karolinska Institute whose laboratory regularly performs the PEth assay according to standardised internationally recognised procedures. At the Karolinska laboratory, whole blood was assayed for PEth 16:0/18:1, using liquid chromatography-tandem mass spectrometry. Self-reported alcohol use and diagnostic categories derived from the application of the AUDIT and MINI tools were compared with PEth results.

In both studies 2 and 3, data were double-entered using OpenClinica version 3.0.1 (OpenClinica, LLC (2014) at MITU and checked for completeness and accuracy, and were analysed using Stata (StataCorp, College Station, TX).

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Chapter 3. Systematic review and meta-analysis: prevalence of alcohol use among young people in eastern Africa

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SECTION A – Student Details

Student	Joel Msafiri Francis
Principal Supervisor	Heiner Grosskurth
Thesis Title	EPIDEMIOLOGY OF ALCOHOL USE AND ALCOHOL USE DISORDERS (AUD) AMONG YOUNG PEOPLE IN NORTHERN TANZANIA

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?	Tropical Medicine and International Health		
When was the work published?	January 2014		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*	**Yes**	Was the work subject to academic peer review?	**Yes**

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Where is the work intended to be published?	
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Stage of publication	Choose an item.

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I developed the study design with inputs from Helen Weiss. I oversaw the study implementation and data collection, Helen Weiss performed a second screening of the eligible articles. I performed data analysis with inputs from Helen Weiss. I interpreted the results and drafted the article and then all

	co-authors provided critical comments on the interpretation of the data and the draft article. I am the guarantor of the paper.

Student Signature: Yunsafiri **Date:** 30.07.2015

Supervisor Signature: [signature] **Date:** 30.7.2015

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Systematic review and meta-analysis: prevalence of alcohol use among young people in eastern Africa

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Abstract

OBJECTIVE Systematic review and meta-analysis of published studies of alcohol use among young people (age 15–24 years) in eastern Africa to estimate prevalence of alcohol use and determine the extent of use of standardised screening questionnaires in alcohol studies.

METHODS Five databases (MEDLINE, EMBASE, Global Health, Africa-wide, and PsycINFO) were searched for publications until 30th June 2013. Results were summarised using the guidelines on preferred reporting items for systematic reviews and meta-analyses (PRISMA) and on quality assessment using the modified quality assessment tool for systematic reviews of observational studies (QATSO). Heterogeneity was assessed using the I^2 statistic (DerSimonian-Laird).

RESULTS We identified 2785 potentially relevant studies, of which 56 were eligible for inclusion. Only two studies (4%) used the standardised Alcohol Use Disorder Identification Test (AUDIT) questionnaire, and six studies (13%) used the Cut down, Annoyed, Guilt, Eye opener (CAGE) questionnaire. The reported median prevalence of alcohol use was ever-use 52% [interquartile range (IQR): 20–58%], use in the last month 28% (IQR: 17–37%), use in the last year 26% (IQR: 22–32%), and problem drinking as defined by CAGE or AUDIT 15% (IQR: 3–36%). We observed high heterogeneity between studies, with the highest prevalence of ever use of alcohol among university students (82%; 95%CI: 79–85%) and female sex workers (66%; 95%CI: 58–74%). Current use was most prevalent among male sex workers (69%; 95%CI: 63–75%).

CONCLUSIONS Reported alcohol use and problem drinking were common among diverse groups of young people in eastern Africa, indicating the urgent need for alcohol-focused interventions in this population. Few studies have used standardised alcohol screening questionnaires. Epidemiological research to investigate alcohol-focused interventions in young people should aim to apply such questionnaires that should be validated for use in this population.

keywords alcohol use, systematic review, meta-analysis, eastern Africa, problem drinking, screening questionnaires, young people, AUDIT, CAGE

Introduction

Harmful alcohol use is a significant public health problem that often begins early in adult life. Globally, an estimated 2 billion people drink alcohol and 76 million have alcohol use disorders (AUD) (WHO 2004). The mean volume of pure alcohol consumed annually by adults globally has been estimated at about 5.0 l per capita (WHO 2004). In Africa, annual consumption of pure alcohol has been estimated to range from 4.9 to 7.1 l per capita (WHO 2004), although intake may be significantly higher because much alcohol consumption is believed to remain unrecorded (WHO 2004). Alcohol use and AUD are associated with more than 60 medical conditions and injuries (WHO 2004; Rehm *et al.* 2006), and about 4% of global mortality and 5% of disability-adjusted life year's (DALYs) lost are attributed to alcohol use (Rehm *et al.* 2009). In the African region, it is estimated that about 2.4% of deaths and 2.1% of DALYs lost are attributed to alcohol use and AUD (Rehm *et al.* 2009). Adverse effects of alcohol use include increased risk of infectious diseases such as HIV/AIDS and TB, and chronic non-communicable diseases (NCD) (Makimoto & Higuchi 1999; Horn-Ross *et al.* 2004; WHO 2004; Ahmed *et al.* 2006; Chen *et al.* 2008; Chong *et al.* 2008; Brooks *et al.* 2009; Genkinger *et al.* 2009; Brandish & Sheron 2010; Kahl *et al.* 2010; Patra *et al.* 2010; Stroffolini *et al.* 2010), as well as intentional and unintentional

injuries, and social problems such as domestic violence, unemployment and decreased work productivity (Gmel & Rehm 2003; Fisher *et al.* 2007; Kalichman *et al.* 2007; Rehm *et al.* 2009; Zaleski *et al.* 2010; Abbey 2011; Aldridge-Gerry *et al.* 2011).

Factors associated with alcohol use include religion, personal income, education level, peer influence, having older sexual partners, stress and relatives and friends using alcohol (Smith *et al.* 1993; Othieno & Obondo 2000; Kuntsche *et al.* 2005; Otieno & Ofulla 2009; Ndetei *et al.* 2009, 2010; Namagembe *et al.* 2010; Amemori *et al.* 2011; Atwoli *et al.* 2011). There are few data, on the patterns of use, harmful consequences of alcohol use among young people, or on the structural and individual factors that lead to the uptake and persistence of harmful alcohol use. A better understanding of the epidemiology of alcohol use among young people is therefore required to facilitate the design of effective alcohol-focused interventions in Africa in general and eastern Africa in particular.

The aim of this article is to systematically review published studies of alcohol use among young people in eastern Africa to estimate the prevalence of alcohol use and the extent of use of standardised alcohol screening questionnaires in preparation for future alcohol-focused intervention studies in this region. The specific objectives of the review were to (i) estimate the prevalence of alcohol use among specific groups of young people (15–24 years) in eastern Africa; (ii) determine the extent of use of standardised alcohol screening questionnaires [Alcohol Use Disorder Identification Test (AUDIT), Cut down, Annoyed, Guilt, Eye opener (CAGE) in identifying alcohol use and AUD in this region; (iii) assess the quality of research papers included in the review; and (iv) describe factors associated with initiation and persistence of alcohol use among young people in eastern Africa.

Methods

Search strategy

Five databases (MEDLINE, EMBASE, Global Health, Africawide-information, and PsycINFO) were searched for publications to 30th June 2013. We used the following key terms: (alcohol use OR alcohol abuse) AND (young people OR adolescent OR teenage OR youth) AND (Africa OR Tanzania OR Kenya OR Uganda OR Ethiopia OR Seychelles OR Rwanda OR Eritrea OR Burundi OR Somalia OR Somaliland OR Comoros OR South-Sudan). (see search details for each database in Appendix S1*)*.

Titles and abstracts of all records identified were screened independently by two authors (JMF and HAW), and consensus on potential eligibility reached. Studies were eligible if they were conducted in eastern Africa (Tanzania, Kenya, Uganda, Ethiopia, Seychelles, Rwanda, Eritrea, Burundi, Somalia, Somaliland, Comoros and South Sudan); and included prevalence of alcohol use for young people aged 15–24 years.

Guidelines on preferred reporting items for systematic reviews and meta-analyses (PRISMA) were used (Moher *et al.* 2009). There is currently an emphasis to incorporate both qualitative and quantitative evidence in the systematic reviews (Pearson 2004; Thomas *et al.* 2004). However, in this review, we focused on determining the prevalence of alcohol use, which was the main objective and therefore we did not include qualitative research papers.

Data extraction

We used a data extraction form to collect the following information from each eligible article: (i) country; (ii) year the study was conducted; (iii) year of publication; (iv) study population (the general population, secondary school students, primary school students, female sex/bar workers, men who have sex with men, health care service attendees and university students); (v) sample size; (vi) definition of alcohol use (ever use, current use, use in the last year, problem drinking); (vii) prevalence of alcohol use and AUD (problem drinking as classified by CAGE and AUDIT); (viii) factors associated with the initiation and persistence of alcohol use; (ix) alcohol use screening questionnaires applied; and (x) complications associated with alcohol use.

A descriptive quality assessment of the final papers included in the meta-analysis was conducted using the modified quality assessment tool for systematic reviews of observational studies (QATSO) (Wong *et al.* 2008). The original QATSO tool is composed of five quality categories that include external validity (sampling strategy used), reporting (response rate and objectivity of measurement), confounding factors, bias (privacy) and a final score based on the mentioned parameters. The primary outcome for this review is prevalence of alcohol use, and the reported response rate was modified to include three categories (>80%, 60–80%, <60%). The assessment of confounding was not required, as the studies did not provide adjustable information on risk factors for alcohol use. We did also not compute the overall final QATSO score based on the five quality categories.

Statistical analysis

We assessed the heterogeneity of prevalence estimates using the I^2 statistic (DerSimonian-Laird) and reported

the prevalence for studies in four groups: (i) ever use of alcohol; (ii) alcohol use in the last year, (iii) alcohol use in the last month (current use) and (iv) problem drinking as defined by CAGE and AUDIT (Ewing 1984; Dersimonian & Laird 1986).

Due to significant heterogeneity between studies, we estimated the median prevalence for each group. We also performed meta-regression to analyse the association between current alcohol use and gender, study setting, and quality assessment parameters (sampling strategy, response rate, interview modality and data collection tool used).

Results

We identified 4013 published study citations from five databases, of which 1228 were duplicates. Thus, 2785 abstracts were screened for initial eligibility to identify studies conducted in eastern Africa. We identified 696 relevant abstracts of studies conducted in eastern Africa. We conducted further screening for studies reporting on alcohol use and identified 285 abstracts for full article review. Of these 285 abstracts for full article assessment, we could not access six full articles, 11 were review articles and five were conference posters.

Thus, we reviewed 263 full-text papers and identified 56 eligible for inclusion in the review. The main reason for exclusion was that the paper did not report information on alcohol use from the target population, that is, young people aged 15–24 years, or that young people were included but we could not separate the prevalence in this age group from that in older people (Figure 1).

Of the 56 eligible studies (Table 1), five reported both current alcohol use and ever use, and one study reported current use and problem drinking and are included in each of these analyses (Zein 1988; Gedif & Eshetu 2007; Mbatia *et al.* 2009; Luchters *et al.* 2011; Kagimu *et al.* 2012; Reda *et al.* 2012). The majority of studies were cross-sectional (n = 54, 96%), and two were case–control studies. Almost all studies (n = 52, 93%) were conducted in four countries: Ethiopia (n = 19), Kenya (n = 15), Tanzania (n = 10) and Uganda (n = 8); the remaining four studies were conducted in Rwanda (n = 2), Seychelles (n = 1) and Eritrea (n = 1). Most studies (n = 36, 58%) reported current alcohol use, 17 studies reported ever use of alcohol, four studies reported alcohol use in the last year, and five studies reported problem drinking. Only two studies used the AUDIT alcohol use screening questionnaire (Mbatia *et al.* 2009; Luchters *et al.* 2011), and six used the CAGE questionnaire [one conducted among female sex workers, three among the general population and two among healthcare attenders (Alem *et al.* 1999; Kebede & Alem 1999; Ghebremichael *et al.* 2009; Kullgren *et al.* 2009; Namagembe *et al.* 2010; Ao *et al.* 2011)]. Of 48 studies that recruited both sexes, only 13 studies (27%) reported gender-specific prevalence of alcohol use. Four studies reported on the factors for initiation and persistence of alcohol use (Otieno & Ofulla 2009; Ndetei *et al.* 2010; Amemori *et al.* 2011; Atwoli *et al.* 2011).

In general, studies were of high quality (Table 2). Most (n = 42, 75%) used probability-based sampling and had a response rate above 80% (n = 33; 58.9%). However, 17 studies did not report the response rate (Bwana 1996; Kuria 1996; Odero & Zwi 1997; Othieno & Obondo 2000; Taffa *et al.* 2002; Maru *et al.* 2003; Ayuku & Odero 2002; Hassan *et al.* 2005; Mbona & Kasirye 2005; Chande & Salum 2007; Khasakhala & Mturi 2008; Molla *et al.* 2008; Tengia-Kessy *et al.* 2010; Ndetei *et al.* 2010; Ao *et al.* 2011; Atwoli *et al.* 2011; Regassa & Kedir 2011). Two-thirds of the studies employed a face-to-face interviewing approach, and a third of studies used self-administered questionnaires; however, all but two studies used self-reported alcohol use. The remaining studies used the alcohol breathalyser (Odero & Zwi 1997; Ayuku & Odero 2002).

Ever use of alcohol

Figure 2 shows the prevalence of reported ever use of alcohol by population groups, including female sex workers, street children, primary school students, secondary school students, general population and university students. Prevalence of reported ever use was highest in the studies among university students [median = 70% interquartile range (IQR): 52–82%] and female sex workers (66%; 95% CI 58–74%). The median prevalence in the four studies among secondary school students was 37% (IQR: 23–56%), although the range was wide, with one study from rural Kenya (Ndetei *et al.* 2010) reporting a prevalence of only 5%. Prevalence was lower among the primary school students (28%; 95% CI: 26–30%), general populations (median = 32%, IQR 17–56%), and among street children 14% (95% CI: 4–24%). Three studies reported gender-specific prevalence of ever-used alcohol; the prevalence was high among females in primary school (36% *vs* 23%) and street children (21% *vs* 11%) and high in male university students (53% *vs* 50%). There was significant heterogeneity based on I^2 statistics in all subgroups, and therefore, we do not report pooled prevalence.

Use of alcohol in the past 12 months

Four studies reported the prevalence of alcohol use in the last 12 months. These showed similar levels as found for

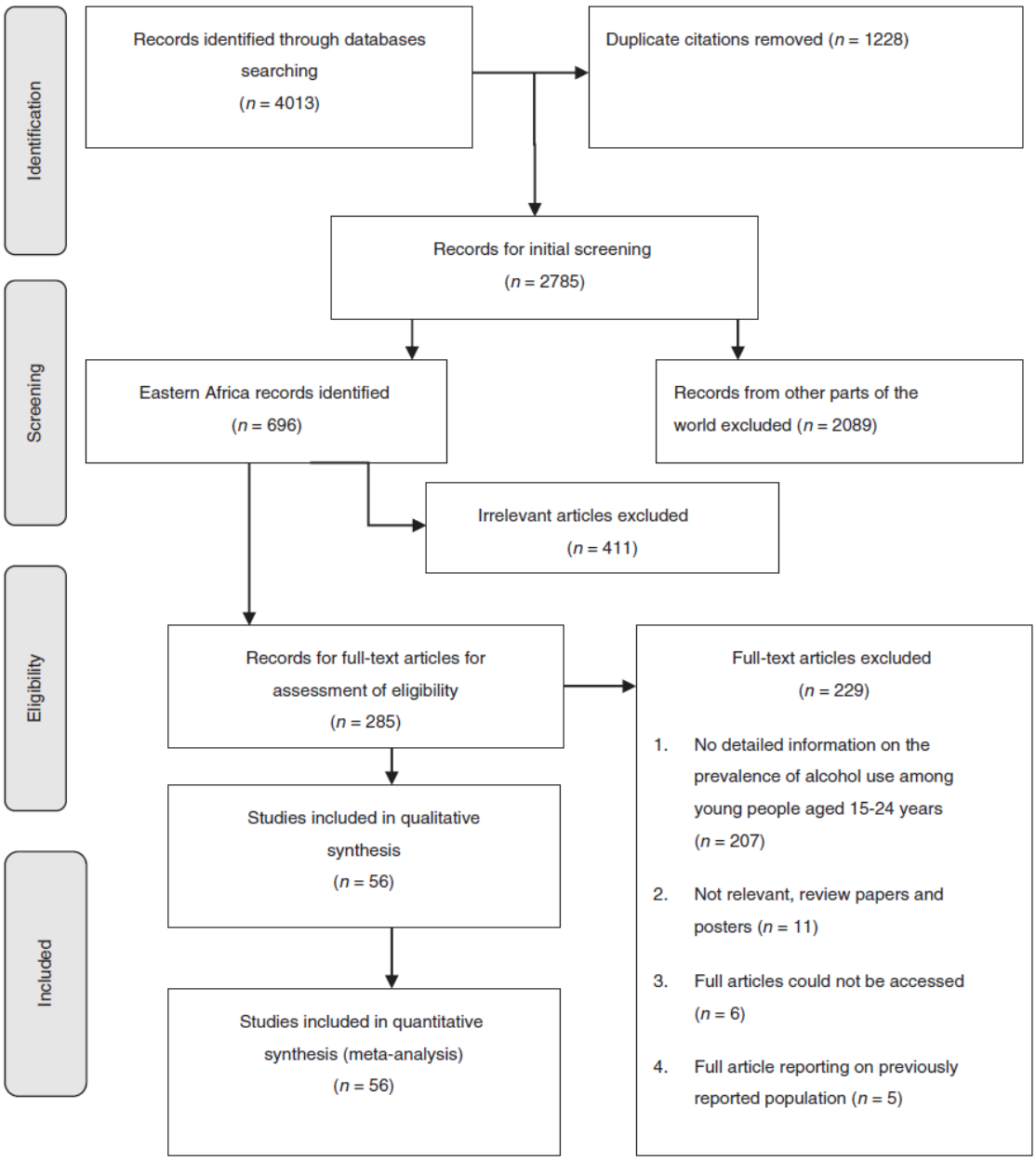

Figure 1 Flow Diagram for literature review.

reported current alcohol use. Three studies were from the general population (median prevalence = 29%, IQR: 21–34%) with a pooled prevalence of 30% (95%CI: 27–33%) and one from university students (prevalence = 22%, 95% CI: 19–25%). One study reported gender-specific prevalence; it was high among males (34% *vs* 17%).

Table 1 Description of studies included in the systematic review and meta-analysis

First author	Year the study conducted	Country	Study population	Sample size	Prevalence	95% CI of prevalence	Alcohol screening tool	Gender	Location
Ever-used alcohol									
Taffa *et al.* (2002)	2000	Ethiopia	General population	561	15.7	12.7–18.7	None	Both	Urban
Mbatia *et al.* (2009)	2003	Tanzania	General population	275	16.7	12.3–21.1	AUDIT	Both	Urban
Zablotska *et al.* (2009)	1994–2002	Uganda	General population	3422	19.8	18.5–21.1	None	Female	Rural
Malaju and Asale (2013)	2012	Ethiopia	General population	405	31.6	27.1–36.1	None	Both	Both
Bwana (1996)	Not reported	Kenya	General population	306	54.9	49.3–60.5	None	Both	Rural
Kagimu *et al.* (2012)	2010	Uganda	General population	530	56.2	52.0–60.5	None	Both	Rural
Fekadu and Alemayehu (2009)	2008	Ethiopia	General population	634	64.0	60.3–67.8	None	Both	Rural
Ndetei *et al.* (2010)	Not reported	Kenya	Secondary school students	343	5.2	2.9–7.6	None	Both	Rural
Reda *et al.* (2012)	2010	Ethiopia	Secondary school students	1721	22.2	20.2–24.2	None	Both	Both
Kuria (1996)	Not reported	Kenya	Secondary school students	952	53.0	49.9–56.2	None	Both	Both
Otieno & Ofulla (2009)	Not reported	Kenya	Secondary school students	458	57.9	53.3–62.4	None	Both	Urban
Othieno and Obondo (2000)	1997	Kenya	Street children	50	14.0	4.4–23.6	None	Both	Urban
Atwoli *et al.* (2011)	2009	Kenya	University students	500	52.0	47.6–56.4	None	Both	Urban
Zein (1988)	1983	Ethiopia	University students	485	70.1	66.0–74.2	None	Both	Urban
Gedif and Eshetu (2007)	2006	Ethiopia	University students	674	81.6	78.7–84.5	None	Both	Urban
Twa-Twa *et al.* (2008)	2003	Uganda	Primary school students	1709	27.8	25.7–29.9	None	Both	Urban
Tegang *et al.* (2010)	2007	Kenya	Female sex workers	137	65.7	57.7–73.6	None	Female	Urban
Alcohol use in the last one year									
Rijken *et al.* (1998)	1993	Tanzania	General population	34	20.6	7.0–34.2	None	Both	Rural
Usman *et al.* (2006)	2004	Eritrea	General population	490	29.4	25.4–33.4	None	Both	Both
Mbona and Kasirye (2005)	2003	Uganda	General population	247	33.6	27.7–39.5	None	Both	Rural
Deressa and Azazh (2011)	2009	Ethiopia	University students	608	22.0	18.7–25.3	None	Both	Urban
Current alcohol use									
Maru *et al.* (2003)	Not reported	Kenya	General population	90	6.7	1.5–11.8	None	Both	Urban
Mbatia *et al.* (2009)	2003	Tanzania	General population	275	9.8	6.3–13.3	AUDIT	Both	Urban
Hargreaves *et al.* (2002)	1996	Kenya	General population	889	11	9.0–13.1	None	Both	Urban
Chande and Salum (2007)	NR	Tanzania	General population	86	11.6	4.9–18.4	None	Both	Urban
Odero and Zwi (1997)	1995	Kenya	General population	28	14.3	1.3–27.2	Breathalyser	Both	Urban
Molla *et al.* (2008)	2004	Ethiopia	General population	3044	17.9	16.5–19.3	None	Both	Both

(continued)

Table 1 (*Continued*)

First author	Year the study conducted	Country	Study population	Sample size	Prevalence	95% CI of prevalence	Alcohol screening tool	Gender	Location
Khasakhala and Mturi (2008)	2002	Kenya	General population	3639	19	17.7–20.3	None	Both	Both
Derege *et al.* (2005)	2001–2002	Ethiopia	General population	20434	21.3	20.7–21.9	None	Both	Both
Kitange *et al.* (1993)	Not reported	Tanzania	General population	1467	23.5	21.3–25.7	None	Both	Both
Kagimu *et al.* (2012)	2010	Uganda	General population	530	30.8	26.8–34.7	None	Both	Rural
Swahn *et al.* (2012)	2011	Uganda	General population	461	32.5	28.3–36.8	None	Both	Urban
Betre *et al.* (1997)	1994–1995	Ethiopia	General population	1436	34.3	31.9–36.8	None	Both	Urban
Mnyika *et al.* (2011)	2002	Tanzania	General population	926	34.6	31.9–37.3	None	Both	Rural
Alemu *et al.* (2007)	2003	Ethiopia	General population	628	43.8	39.9–47.7	None	Both	Urban
Boris *et al.* (2008)	2004	Rwanda	General population	539	49.2	44.9–53.4	None	Both	Rural
Tengia-Kessy *et al.* (2010)	1995	Tanzania	General population	1104	60	57.1–62.9	None	Both	Rural
Namagembe *et al.* (2010)	2006	Uganda	Healthcare service	384	16.4	12.7–20.1	CAGE	Female	Urban
Kullgren *et al.* (2009)	2007	Uganda	Healthcare service	76	21.1	11.9–30.2	CAGE	Both	Urban
Hassan *et al.* (2005)	1999	Kenya	Healthcare service	45	24.4	11.9–37.0	None	Both	Urban
Ayuku and Odero (2002)	1995–1996	Kenya	Healthcare service	778	26.5	23.4–29.6	Breathalyser	Both	Both
Luchters *et al.* (2011)	2008	Kenya	Male sex workers	222	68.9	62.8–75.0	AUDIT	Male	Urban
Kebede and Ketsela (1993)	1989–1990	Ethiopia	Secondary school students	519	9.2	6.8–11.7	None	Both	Urban
Dhadphale *et al.* (1982)	Not reported	Kenya	Secondary school students	2918	10.3	9.2–11.4	None	Both	Both
Reda *et al.* (2012)	2010	Ethiopia	Secondary school students	1721	10.4	9.0–11.8	None	Both	Both
Shiferaw *et al.* (2011)	2009	Ethiopia	Secondary school students	240	26.7	21.1–32.3	None	Both	Rural
Tengia-Kessy *et al.* (2010)	2008	Tanzania	Secondary school students	400	39.0	34.2–43.8	None	Both	Urban
Van Decraen *et al.* (2012)	Not reported	Rwanda	Secondary school students	285	43.9	38.1–49.6	None	Both	Rural
Lioul and Jemal (2009)	2005	Ethiopia	Secondary school students	810	51.5	48.0–54.9	None	Both	Urban
Faeh *et al.* (2006)	Not reported	Seychelles	Secondary school students	390	60.5	55.7–65.4	None	Both	Urban
Arnold *et al.* (2008)	2006	Ethiopia	University students	1330	19.2	17.1–21.3	None	Female	Urban
Regassa and Kedir (2011)	2010	Ethiopia	University students	606	29.7	26.1–33.3	None	Both	Urban
Amemori *et al.* (2011)	2006	Tanzania	University students	66	30.3	19.2–41.4	None	Both	Urban

(continued)

Table 1 (*Continued*)

First author	Year the study conducted	Country	Study population	Sample size	Prevalence	95% CI of prevalence	Alcohol screening tool	Gender	Location
Zein (1988)	1983	Ethiopia	University students	485	31.1	27.0–35.3	None	Both	Urban
Philpart *et al.* (2009)	2006	Ethiopia	University students	1378	31.2	28.8–33.7	None	Male	Urban
Gedif and Eshetu (2007)	2006	Ethiopia	University students	674	31.2	27.7–34.7	None	Both	Urban
Agardh *et al.* (2011)	2005	Uganda	University students	980	41.1	38.0–44.2	None	Both	Rural
Problem drinking									
Kebede and Alem (1999)	1994	Ethiopia	General population	4586	1.2	0.9–1.5	CAGE	Both	Urban
Alem *et al.* (1999)	Not reported	Ethiopia	General population	2997	2.6	2.0–3.2	CAGE	Both	Rural
Ghebremichael *et al.* (2009)	2002–2003	Tanzania	General population	214	15.0	10.2–19.7	CAGE	Female	Urban
Ao *et al.* (2011)	2002–2006	Tanzania	Female bar workers	723	36.2	32.7–39.7	CAGE	Female	Urban
Luchters *et al.* (2011)	2008	Kenya	Male sex workers	222	46.8	40.0–53.0	AUDIT	Male	Urban

AUDIT, Alcohol Use Disorder Identification Test.

Current use of alcohol

Current alcohol use may be more relevant than ever use for designing intervention strategies. The prevalence of reported current alcohol use is presented in Figure 3 for general populations, healthcare service attendees, male sex workers, secondary school students and university students. Heterogeneity was highest in studies conducted in general populations and among secondary school students. The prevalence was highest in the one study among male sex workers (69%; 95%CI: 63–75%). Median prevalence among secondary school students was 33% (IQR: 10–48%) and 31% (IQR: 30–31%) among university students and was lower in the general population (median 22%; IQR: 13–34%) and healthcare attenders (median 23%; IQR: 16–24%). Eight studies reported gender-specific prevalences. The median prevalence was high among males; 21% (IQR: 7–26%) *vs.* 9%(IQR: 9–20%) in the general population, 28% (IQR: 13–44%) *vs* 19%(IQR: 7–32%) among healthcare service attenders, 60% (IQR: 56–63%) *vs.* 41% (IQR: 24–58%) in secondary schools, and 43% *vs.* 28% in a university. There was no significant heterogeneity in studies conducted among university students except one study among female university students (Arnold *et al.* 2008). Reported current alcohol use was more common among males than females and not associated with other factors.

Problem drinking

Problem drinking among young people was reported in five studies, three from the general population, one from female bar workers and one from male sex workers. The prevalence of problem drinking was 36% (95%CI: 33–40%) among female bar workers and 47% (95%CI: 40–53%) among male sex workers. Median prevalence in the general population was 3% (IQR: 1–15%); two of the studies in the general population were from Ethiopia and showed low levels of problem drinking (1–3%), but a study from Tanzania reported a rather high median prevalence of 15% (95%CI: 10–20%).

In this review, eight studies reported problematic drinking, two studies applied AUDIT, and six (13%) used CAGE to screen for problem drinking; two of the studies that applied CAGE and one study that applied AUDIT did not report scores according to age groups (Kullgren *et al.* 2009; Mbatia *et al.* 2009; Namagembe *et al.* 2010).

Discussion

Among young people in eastern Africa, alcohol use is common and its extent of use varies between specific

Table 2 Quality of the papers included in the systematic review and meta-analysis

Quality variable	Quality variable categories	Number of studies	Proportion (%)
Sampling	Non probability	14	25.0
	Probability	42	75.0
Alcohol use information collection	Breathalyser	2	3.6
	Alcohol Use Disorder Identification Test	2	3.6
	CAGE	6	10.7
	Other self-reports	46	82.1
Response rate	Between 60 and 80%	6	10.7
	Above 80%	33	58.9
	Not reported	17	30.4
Interview modality	Face to face	36	64.3
	Self-administered	20	35.7

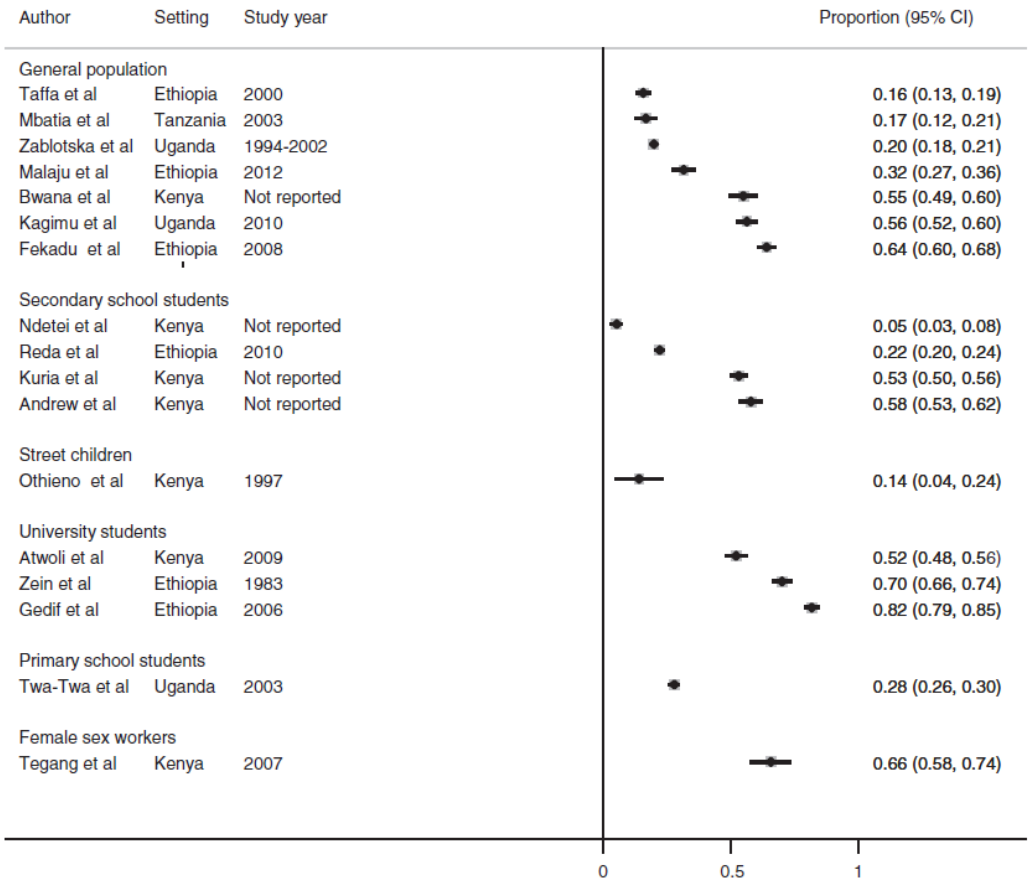

Figure 2 Prevalence of ever use of alcohol among studies included in the systematic review and meta-analysis.

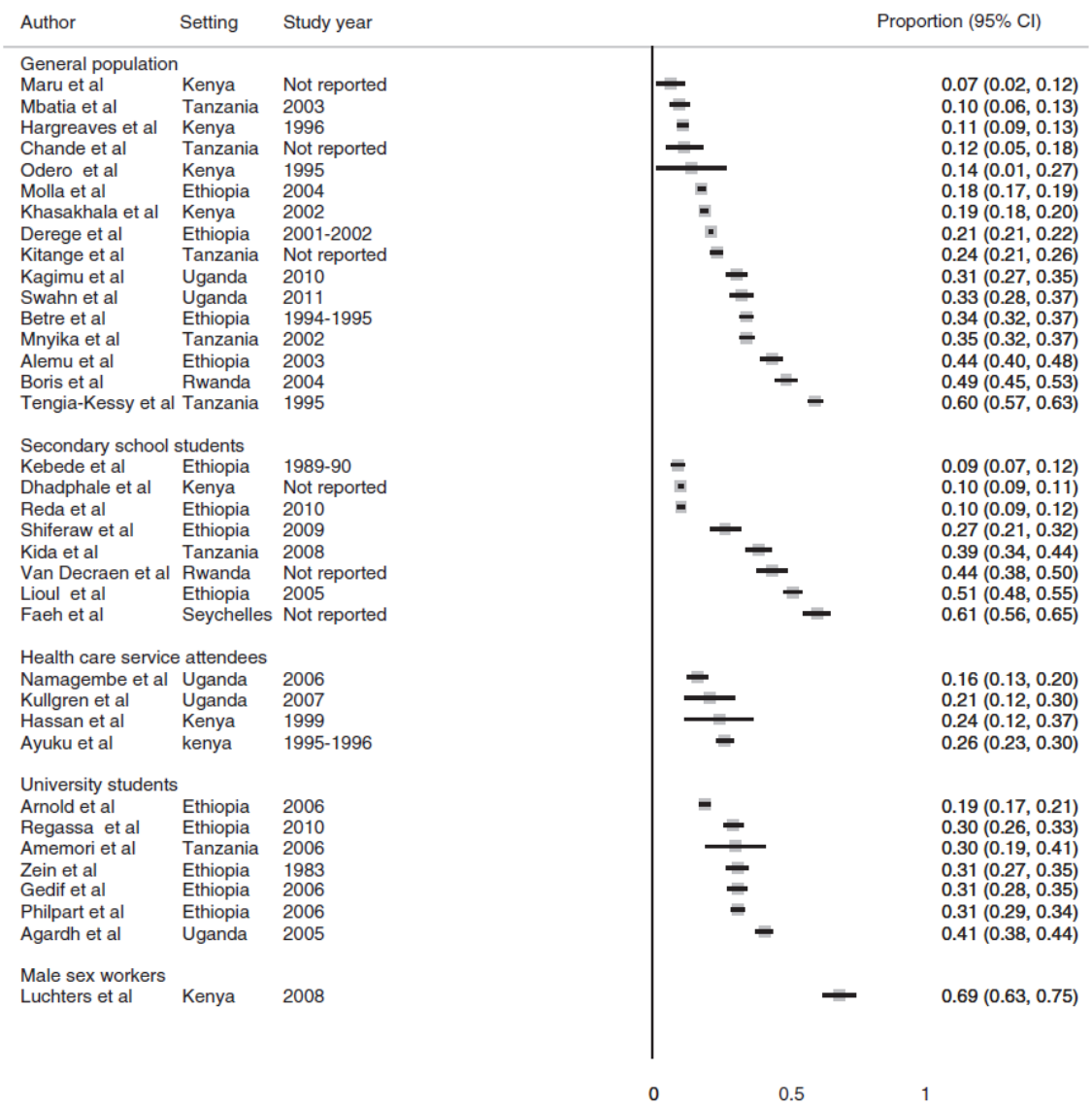

Figure 3 Prevalence of current alcohol use among studies included in the systematic review and meta-analysis.

populations and settings. Due to high level of heterogeneity between studies, we did not report pooled prevalence. The prevalence of reported ever use was highest among university students (70%) and female sex workers (66%) and lower among the general population and primary school students. Few studies reported alcohol use in the last year, and median prevalence in the general population was 29%. Reported current alcohol use was highest among male sex workers (69%), followed by the university students (33%), and was lowest in the general population and secondary school students with the exception of one study in the Seychelles that reported a high prevalence of 61%. Problem drinking was highest among groups known to engage in high-risk behaviours (such as bar workers and sex workers). Generally, reported alcohol use across all definitions of use was highest among

groups known to engage in high-risk behaviours, followed by university students. Individuals attending healthcare services and general populations and secondary school students reported the lowest prevalence. Studies included in this review were of good quality; however, about two-thirds employed face-to-face interviewing approaches, an approach prone to social desirability bias that could lead to underreporting of alcohol use.

The varied prevalence of reported alcohol use among groups of young people is potentially due to specific population characteristics (general population *vs.* students *vs.* sex workers). We also attribute these variations to social influence and peer pressure (Smith & Foxcroft 2009; Li *et al.* 2010a,b). For example, the high prevalence of reported alcohol use among secondary school students from the Seychelles may be attributed to the relatively high purchase power of young people in this study population (Faeh *et al.* 2006). In addition, study settings, gender and use of non-standardised alcohol screening questionnaires could partially explain these variations.

Problem drinking was common among young sex workers and female bar workers. Several factors may have contributed to this, including the intertwined nature of bar work and transactional sex – the negotiation of commercial sex usually involves drinking. Also bar workers' psychosocial history, multiple sexual partners, level of education, religion, marital status, number of pregnancies and living conditions, for example, not living within the drinking establishment were found to influence problematic drinking in studies from eastern Africa (Ao *et al.* 2011; Kagimu *et al.* 2013).

The varied prevalence of reported alcohol use for specific groups of young people and the varied risk factors associated with it implies that the need for alcohol interventions is not uniform for all groups of young people. The interventions should address specific needs of a targeted group. For example, in the eastern Africa context, we may need to develop specific strategies to reduce harmful alcohol use among college students, bar workers and commercial sex workers.

An important finding of our review was lack of data on the initiation and persistence of alcohol use among young people in this region. Few studies mentioned factors associated with the initiation of alcohol use, such as peer influence, family and friends, religion and sexual experiences (Otieno & Ofulla 2009; Ndetei *et al.* 2010; Amemori *et al.* 2011; Atwoli *et al.* 2011). Future studies should aim to elicit in-depth information on social factors influencing alcohol use to inform potential interventions.

The use of effective and validated instruments for the screening and assessment of alcohol use is essential to guide research and is important for the design and evaluation of interventions. AUDIT is validated and recommended by WHO for use at the primary healthcare settings and for the assessment of AUD in developing countries (Saunders *et al.* 1993; Chishinga *et al.* 2011; Kapiga *et al.* 2013); it is, however, not widely used for the assessment of AUD among young people in general populations. In our review, only two studies used the internationally recommended AUDIT alcohol screening questionnaire (Mbatia *et al.* 2009; Luchters *et al.* 2011).

Conclusion

Reported alcohol use among young people in eastern Africa is common and varies between different populations. The prevalence of AUD was highest among populations known to engage in high-risk sexual behaviours, but was also high among students in some of the studies. The studies reviewed lacked data about initiation and persistence of alcohol use, and little information was available about risk factors associated with alcohol use, and AUD. Notably, only few of the studies reviewed used internationally recommended and validated screening questionnaires such as AUDIT. Future epidemiological studies on alcohol use among young people should apply these questionnaires to facilitate comparison. However, such questionnaires have not been evaluated among young people in Africa, and studies closing this knowledge gap are therefore also required. Future studies should also determine factors responsible for initiation, persistence, and patterns of use in preparation for potential interventions. There is an urgent need of targeted interventions for groups of young people with a particularly high risk of alcohol use and AUD such as college students and young sex workers.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Search Strategies.

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Chapter 4. The epidemiology of alcohol use and alcohol use disorders among young people in northern Tanzania

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SECTION A – Student Details

Student	Joel Msafiri Francis
Principal Supervisor	Heiner Grosskurth
Thesis Title	EPIDEMIOLOGY OF ALCOHOL USE AND ALCOHOL USE DISORDERS (AUD) AMONG YOUNG PEOPLE IN NORTHERN TANZANIA

If the Research Paper has previously been published please complete Section B, if not please move to Section C

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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	Plos one
Please list the paper's authors in the intended authorship order:	Joel M Francis, Helen A Weiss, Gerry Mshana, Kathy Baisley, Heiner Grosskurth, Saidi H Kapiga
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SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I developed the study design with inputs from Helen Weiss, Heiner Grosskurth and Saidi Kapiga. I oversaw the study implementation and data collection. I performed data analysis with inputs from Helen Weiss and Kathy Baisley. I interpreted the results and drafted the article and then all co-authors provided

	critical comments on the interpretation of the data and the draft article. I am the guarantor of the paper.

Student Signature: _____ **Date:** 30. 07. 2015

Supervisor Signature: _____ **Date:** 30.7.2015

The epidemiology of alcohol use and alcohol use disorders among young people in northern Tanzania

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Abstract

Introduction

Alcohol use is a global public health problem, including as a risk factor for HIV infection, but few data are available on alcohol use among young people in sub-Saharan Africa.

Methods

We conducted cross-sectional surveys among 4 groups of young people aged 15-24 years old (secondary school students, college/university students, employees of local industries and casual labourers) in two regions (Kilimanjaro and Mwanza) of northern Tanzania. Using a multistage stratified random sampling strategy, we collected information on demographics, alcohol use, and behavioural factors. We screened severity of alcohol use using the Alcohol Use Disorder Identification Test (AUDIT) and estimated the quantity and frequency of alcohol consumption using a timeline-follow-back-calendar (TLFB) method.

Results

A total of 1954 young people were surveyed. The prevalence of reported alcohol use was higher among males (47-70% for ever use and 20-45% for current use) than females (24-54% for ever use and 12-47% for current use), and this was significant among students ($p<0.001$). Prevalence was substantially higher in Kilimanjaro than Mwanza region. In both regions, there was reported high exposure to alcohol advertisements, and wide alcohol availability. Among the groups, college students reported the highest prevalence of current alcohol use (45% among males; 26% among females) and of heavy episodic drinking (71% among males; 27% among females) followed by casual labourers. Males were more likely to have alcohol use disorders (an AUDIT score ≥8) than females, with 11-28% of males screening positive for alcohol use disorders. Alcohol use was associated with male gender, being in a relationship, greater disposable income, non-Muslim religion and a higher number of sexual partners.

Conclusions

Alcohol use is a significant problem among young people in northern Tanzania. There is an urgent need to pilot and deliver interventions to help young people delay initiation and reduce levels of harmful drinking, particularly among college students and casual labourers.

(301 words)

Introduction

Excessive alcohol use is a global public health problem accounting for about 6% of mortality and 5% of disability adjusted life year's (DALYs) lost worldwide [1]. The World Health Organization (WHO) estimate that, globally, about 53% of people aged 15 years and above have ever used alcohol and 39% used it in the last year [1]. Within Africa, an estimated 43% of those aged 15 years or above have ever used alcohol and 30% used it in the last year [1]. The reported prevalence of alcohol use disorders (AUD) (defined by an Alcohol Use Disorders Identification Test (AUDIT) score ≥8) is estimated at 4% globally and 3% in Africa, and is generally more prevalent among men [1]. AUD are associated with acute and long-term medical complications [1-3] and may interfere with the treatment of chronic diseases such as diabetes and HIV/AIDS due to poor treatment adherence [4,5]. Alcohol use and AUD are also associated with intentional and unintentional injuries, domestic violence, unemployment and decreased work productivity [6-10].

Data from industrialized countries show that excessive alcohol use often begins at young age [11-14]. In 2012, according to WHO, 46% of the world's adolescents aged 15-19 years reported having ever used alcohol, and 34% had used it in the last year. In Africa, these estimates were 41% and 29% respectively [1]. The prevalence of heavy episodic drinking in adolescents was 8% globally and 6% in Africa, and higher among adolescents than adults [1]. Adolescents and young adults tend to experiment, and the intake of excessive amounts of alcohol may be a consequence of this [11-14]. Previous studies from Europe, America and some settings in sub-Saharan Africa (SSA) show that risk factors predisposing young people to excessive alcohol use include male gender, peer pressure, family history of alcohol abuse, unstable employment, economic uncertainties, poor social and coping skills, increased alcohol availability, and positive expectations regarding

alcohol use [15-18]. In recent years, alcohol advertisements have become widespread in SSA and in other regions of the world. Most advertisements propagate drinking as modern and associated with occupational and sexual achievements [19-21].

Our recent systematic review showed that alcohol use is common among young people aged 15-24 years in East Africa with the highest levels recorded among sex workers and college students [22]. However, the review also highlighted a lack of data on the prevalence of alcohol use among young people in this region [22]. To inform health policy and intervention planning, we studied the epidemiology of alcohol use among different groups of young people in two populous regions of northern Tanzania.

Methods

Study setting

Between July 2012 and June 2013, we conducted a cross-sectional survey to determine the patterns of and risk factors for alcohol use and AUD among young people in Kilimanjaro and Mwanza regions of northern Tanzania. These regions were purposely selected to represent divergent socio-economic conditions and cultural diversity including social norms for young people. We surveyed young men and women from four groups: (i) secondary school students, (ii) college students, (iii) young people employed in local industries and (iv) casual labourers recruited from construction sites, car workshops and farms, as a proxy for youth without employment as these are otherwise difficult to identify. We obtained ethical approvals from the Tanzania National Health Research Ethics Committee (NIMR/HQ/R.8a/vol. IX/1339) and the London School of Hygiene and Tropical Medicine (LSHTM ethics ref: 6149).

Sampling strategy

We used a stratified multistage sampling scheme, with 4 strata (2 in each region): Nyamagana and Sengerema, an urban and rural district, respectively, in Mwanza region, and Moshi urban and Moshi rural districts in Kilimanjaro. Owing to funding constraints, not all districts in each region could be sampled; therefore, the districts were randomly selected from among the rural and urban districts in each region. Study participants were aged 15-24 years, provided written informed assent or consent and lived in one of the selected districts. Primary sampling units (PSUs) were educational institutions and work places. Sampling was done without replacement. We originally planned to survey 128 men and 128 women from each of the 4 groups from each district (256 men and 256 women per group; Figure 1). However, there were fewer than expected young persons

among employees of local industries and casual labourers, and therefore we surveyed all available individuals within the eligible age range for these two groups. In Mwanza region, we expanded recruitment for these two groups to all available individuals from the other three districts; with the exception of Ukerewe district, an island archipelago that was excluded for logistical reasons. Recruitment was not expanded in Kilimanjaro region because we reached targeted sample for the casual labourers in Moshi urban and rural districts, and there were no operational local industries in other rural districts.

Within each district, educational institutions and classes were selected by simple random sampling, using random numbers generated by Stata 12.1 (StataCorp (2011), College Station, TX).

Secondary school students: We obtained a list of all secondary schools in the selected districts, including government and private schools, and boarding and day schools. In Nyamagana, Sengerema, Moshi urban and Moshi rural districts, there are 44, 40, 30 and 96 secondary schools, respectively. We randomly selected two schools from each district. From each school, we randomly selected two classes (excluding final year classes preparing for the national examinations), and from each class we randomly selected 16 boys and 16 girls.

Students of colleges and universities: Students enrolled in colleges and universities pursuing ordinary diploma, advanced diploma or undergraduate degree programs were eligible to take part in the study. In Nyamagana, Sengerema, Moshi urban and Moshi rural districts, there were 4, 3, 3 and 5 colleges/universities respectively, of which 2 were randomly selected per district. In each institution, we obtained a list of courses/programmes and randomly selected two for inclusion in the study. From each course/programme, we randomly select 16 men and 16 women.

Industrial employees: We surveyed employees from all identified non-alcohol producing industries who had been employed for at least six months. From each work place, we obtained a list of eligible workers from the employers and surveyed everybody who consented. Industries comprised soft drink and mineral water-bottling factories, and fish and food processing industries (urban Mwanza districts), cotton ginneries and metal processing workshops (rural Mwanza districts); soft drink, paper, tannery and match industries (Moshi urban) and sugar cane and coffee plantations (Moshi rural).

Casual labourers: We surveyed all available eligible short-term workers we could find at all identified building and road construction sites, car workshops and plantations from all districts in Mwanza region except Ukerewe and Moshi urban and Moshi rural districts in Kilimanjaro region.

Data collection and ethical considerations

After the sites were selected, we obtained permission to conduct interviews from the head of the educational institutions or companies involved. Trained research assistants provided information about the study to groups of potential participants at the selected schools, colleges and work places. Students were informed about the study, and were invited to give written assent (if they were between 15 and 18 years old); or written consent (if they were aged 18 years or above). For day schools, one week prior to data collection, an information sheet was provided to students to present to their parents. Through this information sheet, parents were informed about the study, and invited to raise any questions, objections or concerns they might have, and to contact the investigators with these. This gave parents an opportunity for their children to opt out of the study if they wished to do so. For boarding schools, given communication limitations in Tanzania, this procedure was not possible. In this situation, we obtained verbal

permission from the respective class teachers, in addition to written personal assent or consent. This study and consent procedure was approved by the Tanzania National Health Research Ethics Committee (NIMR/HQ/R.8a/vol. IX/1339) and the Ethics Committee of the London School of Hygiene and Tropical Medicine (LSHTM ethics ref: 6149). The principal investigator provided information on the effects of alcohol use. We could not refer young people with hazardous/harmful/problematic alcohol use, as these services are not available in the study settings. All data were collected anonymously, i.e. the questionnaires did not have personal identifiers, and it was therefore not possible to trace individual responses to specific students. Participants were interviewed in private using a pre-tested structured questionnaire (S1 File). Completed questionnaires were securely stored in the field and were submitted to Mwanza Intervention Trials Unit (MITU)'s data section for further processing.

Primary study variables

Data collection tools were administered using Swahili, which is the Tanzania national language. These tools had been previously applied in other studies in the northern Tanzania settings conducted by the National Institute for Medical Research (NIMR) and Mwanza Intervention Trials Unit (MITU).

The main outcome was prevalence of reported alcohol use (ever, in the last 12 months, the last 2 months, and the last 30 days). Other outcomes included the frequency and amount of alcohol consumed (defining 10g of pure ethanol as one standard drink) [23], the prevalence of hazardous/harmful/dependent alcohol use assessed by the WHO-AUDIT questionnaire (AUDIT score of $\geq$8), and the prevalence of suspected alcohol dependence based on DSM IV criteria [24,25].

Additional questions on alcohol use included the perceived possible adverse effects of alcohol with regards to school or work performance, use of alcohol by siblings, exposure to alcohol advertisements, alcohol availability and personal views about alcohol; the circumstances of participants' first ever alcohol use, the type of alcoholic beverage used at the time, type currently preferred, drinking habits over the last year. We used the alcohol timeline follow-back (TLFB) calendar method to obtain detailed information on alcohol use over the past sixty days [26]. For any day in the calendar with reported alcohol use, the number of standard drinks consumed was estimated using a pictorial display of different types of drinks (S2 File). We also asked about the consumption of traditional (locally brewed) alcoholic drinks.

We also collected information on age, disposable cash in a month, marital or relationship status, region of residence, sexual risk taking under the influence of alcohol, history of sexually transmitted infections (STIs), casual sex in the last month, and number of lifetime sexual partners and partners during the last year.

Sample size

Due to the heterogeneity of different groups regarding socio-economic status and alcohol use, the sample size was estimated to provide adequate precision within each group. Based on the literature on alcohol use among young people in Tanzania [27-29], we assumed the overall prevalence of current alcohol use to be about 20% and chose a sample size to estimate this prevalence with a precision of 5% within each of the four groups. Assuming a design effect of 2 due to the clustered study design, the estimated minimum sample size required per group was 490 [30]. To allow for a non-response rate of about 5%, we aimed to recruit 512 participants from each group. For the investigation of risk factors associated with alcohol use in each group, this sample size provides 80%

power to estimate odds ratios of 2.0 if the proportion of young people with the outcome was 15% among those unexposed.

Data management and analysis

Field supervisors checked the completed questionnaires for consistency and quality at the end of each day. Data were double-entered using OpenClinica version 3.0.1 (OpenClinica, LLC (2014) and checked for completeness and accuracy, and were analysed using Stata 12.1 (StataCorp (2011), College Station, TX) stratified by study group. We accounted for the stratified and multi-stage survey design using STATA's survey procedures. To allow for the differential probability of selection (since the sampling scheme was not self-weighting), we applied sampling weights for the analysis of data from the secondary school and college/universities. For employees and casual labourers, we did not apply sampling weights since we surveyed all available individuals at every eligible employment site. Due to the small number of PSUs in each stratum, we estimated variances using a repeated half-sample bootstrap algorithm that gives a less biased estimate of the variances in a situation with few PSUs, and constructed the confidence intervals using the percentiles of the bootstrap distribution [31].

For AUDIT questions, we computed total scores and categorised AUDIT scores as binary with a cutpoint of ≥8 to indicate AUD and that could be either hazardous or harmful or problematic alcohol use/possible dependence [24]. For the amount of alcohol reported for each specific event in the TLFB calendar, we computed the number of drinking events and the consumption per event, and estimated the median and interquartile ranges. For the analysis of DSM-IV data, we generated scores from the responses(Yes=1 and No=0) to dependence and abuse questions in order to allocate respondents' drinking behaviour to either: alcohol dependence (if $\geq$3 dependence characteristics met), alcohol abuse

without dependence (at least 1 abuse characteristic met) and no alcohol abuse (0 characteristics met) [25].

To assess factors associated with each binary outcome (ever use, use in the last year, and hazardous alcohol use) we used logistic regression, allowing for the survey design and with sampling weights applied (except for the two work place groups). Associations with AUD were only analysed for male participants as the number of individuals with this outcome was small among females. For the multivariable models, region (Mwanza or Kilimanjaro), religion and sex were included as a priori confounders; and other factors associated in the univariable analysis (disposable cash in a month, age, marital status and having siblings who use alcohol and risky sexual behaviours) were included as they had p-values of ≤ 0.1. We retained these factors in the final model if they were independently associated with the outcome ($p \leq 0.05$). We report crude and adjusted odds ratios (AOR) and their 95% confidence intervals (CI). We assessed the interaction between sex and all exposure variables, and location and all exposure variables, respectively.

Results

Recruitment and sample characteristic

We surveyed 1954 young people, 960 (49%) in Mwanza region and 994 (51%) in Kilimanjaro region. These included 517 secondary students, 525 college and university students, 423 employees of local industries and 489 casual labourers. Response rates were high in all four groups (Figure 1). All selected schools/workplaces consented to participate in the survey.

More men than women were recruited from local industries (71%) and from casual labourers (91%) as they are predominantly male occupation in the study settings. Demographic and behavioural characteristics are shown in Table 1, and varied between the groups as expected by age, marital status, education level, income and sexual behaviours.

Most participants reported having seen alcohol advertisements in the last month (from 67% among school students to 89-99% among other groups), many reported having seen alcohol advertisements almost daily (37-79%) and the majority in each group reported having seen movie or cinema actors drinking alcohol in most of the films (61-92%). About two-thirds (64%) of secondary school students and almost all (>95%) of participants from other groups reported that it was very easy to obtain alcohol if they wanted. Almost all participants perceived alcohol as harmful (95-100%) and about half reported having siblings who drank alcohol (30-59%) (Table 2).

Prevalence and epidemiology of reported ever and recent use of alcohol

Reported alcohol use was common and was higher among males than females across all groups (Table 3) but significantly different among students groups ($p<0.001$). Prevalence

of ever use of alcohol was highest amongst male college students (70.4%, 95%CI: 54.8-74.2) and male casual labourers (61.0%, 95% CI: 51.4-67.7), and lowest among female secondary students (24.0%, 95%CI: 19.2-30.6). The prevalence of recent alcohol use (reported use in the last two months) followed a similar distribution pattern, although among casual labourers it was higher among women than men, and ranged from 3% among female school students to 30% among female casual labourers. Reported alcohol use was significantly higher in Kilimanjaro than Mwanza region for all groups except for college students.

Ever use of alcohol was strongly associated with residence in Kilimanjaro among secondary students (AOR=4.36, 95%CI: 2.71-9.21), employees in local industries (AOR=5.28, 95%CI: 2.62-11.61), and casual labourers (AOR=3.53, 95% CI: 1.73-5.58) (Table 4). Other factors independently associated with ever use of alcohol included male gender (AORs ranging between 1.25 to 4.00), having siblings who drink alcohol, being in a relationship, and among college students having disposable cash that was above average. Belonging to a non-Muslim faith was generally associated with ever use of alcohol. Associations with reported alcohol use in the last year followed a similar pattern as described in Table 5.

Ever use of alcohol and use in the last year was associated with reporting two or more sexual partners both over lifetime and last year across all groups of young people (Tables 4&5), with AORs ranging from 1.2 – 9.0.

Prevalence and epidemiology of AUD

AUD was highly prevalent among male college students (27.5%, 95% CI: 13.6-30.9%); and common among male casual labourers (13.7%, 95%CI: 8.0-18.3%) and male secondary

students (10.6%, 95%CI: 3.8-16.6%) (Table 3). Relatively few women screened positive for AUD, and this was highest among casual labourers (7.0%, 95% CI: 0.0-9.1%) and college students (6.5%, 95%CI 2.3-9.8%). Using DSM IV criteria, around 5% of male secondary students and male casual labourers, and 4% of male and female college students were classified as alcohol dependent.

The prevalence of AUD did not vary significantly between regions except for male secondary school students from Kilimanjaro region who were more likely to be affected than male secondary school students in Mwanza. AUD was associated with older age, higher disposable cash in a month, having a sibling who drank alcohol, and having $\geq$2 lifetime sexual partners (Table 6).

Initiation and persistence of alcohol use

The majority of participants reported that they had their first drink at a social event (during a public holiday, a family celebration, wedding (S1 Table). The first drink was most commonly bottled beer (31%-66%). Local brew was also a common first drink (36%-45%), especially among secondary school girls. The main motive reported for initiating alcohol use was “wanting to try” or a combination of reasons for example “wanting to try and convinced by a friend”. Among non-drinkers, reasons for avoiding alcohol included the influence of parents or other relatives, religion and being afraid of side effects. Among previous users of alcohol, the main reason for not drinking was a dislike of alcohol (67% of the female casual workers to 99% of the male college students who had been abstinent in the last year).

Patterns of alcohol use in the last year

Among participants who had used alcohol during the last year, most had a preference for bottled beer (from 24% of male secondary students to 60% of male college students), and wine was also popular among females (Table 7). The consumption of locally brewed drinks was reported by up to 35% of participants, although not among college students (Table 7).

Male college students and casual workers reported the highest frequency of heavy episodic drinking (Table 7). For example, 64% of male college students reported to have more than 6 drinks on a typical drinking occasion, and 11-14% of college students and casual labourers reported having such occasions every week.

Frequency and amount of alcohol used over the last 2 months

Alcohol use in the last 2 months was reported by 3% of female and 9% of male secondary school students; 16% of female and 27% of male college students; 11% of female and 14% of male employees; and by 30% of female and 18% of male casual workers respectively (S2 Table). Based on the TLFB method, male college students and male casual labourers reported the highest alcohol consumption (71% and 57% respectively) (S2 Table). Male employees and female casual labourers reported a similar number of drinking events with a lower median monthly number of standard drinks. Women of the other three sub-groups reported low levels of alcohol consumption.

Discussion

Alcohol use was common among young people in northern Tanzania. Across different groups the prevalence was 47-70% for ever use and 20-45% for use during the past year, and was particularly high among college students and casual workers; and with the exception of female casual workers higher among men than women. Estimated alcohol use in our study was greater than the WHO estimates for Africa among young people and than data collated in a systematic review of alcohol use among young people in East Africa [1,22]. Our findings were similar to the estimated prevalence of alcohol use among young people in the United States (US) (71% for ever use, 53% for current use) but lower than estimates from Europe[1].

We found the prevalence of episodic drinking to be similar to that reported for the general population and for college students in the US and Europe [1,32]. Young men were more likely to screen positive for hazardous/harmful/dependent alcohol use based on AUDIT and dependence by DSM IV tests, and this was consistent with other reports from Africa and elsewhere in the world [1,33].

Reported alcohol use was higher in Kilimanjaro than in Mwanza region, possibly due to local cultural beliefs in Kilimanjaro that encourage alcohol use [34]. The role of cultural influences on the drinking behaviour of young people has been shown also by others [35]. The lack of association between alcohol use and region among college students supports this explanation, as college students involved in this survey were drawn from different cultural settings in Tanzania. Young people initiate alcohol use for a variety of reasons including a desire to better cope with stressful situations, social motives and positive enhancements experienced through alcohol [15,36]. In this study, young people reported "wanting to try alcohol" as their main reason to initiate alcohol use. Industrially -made

beer was the most commonly reported beverage. However, a substantial number of young people also reported the use of local beer, and spirits or liquors.

Socio-demographic characteristics associated with alcohol use in this study were similar to those found in studies conducted in North America and Europe included higher than average disposable cash in a month, religion (Catholic), being married or in a relationship, and having siblings who drink alcohol [35,37,38].

Apart from the cultural and family related influences described, a number of other structural factors may play a role in alcohol initiation and persistence among young people. Most participants reported that they had been exposed to alcohol advertisements frequently and that it was easy for them to obtain alcohol if they wanted to. Alcohol was comparatively inexpensive and affordable even to individuals who had no reliable cash income. The influence of these and possibly other structural factors seems to be substantial, as drinking habits were formed in spite of information about the negative implications of alcohol that the great majority of our participants had obtained at school, and in spite of the almost ubiquitous conviction that alcohol may be harmful.

Alcohol use was associated with risky sexual behaviours (reporting more than one sexual partner over time) in this study, in line with the scientific literature which supports associations of alcohol use and sexually transmitted infections and risky sexual behaviours indicating the need to incorporate alcohol reduction interventions in ongoing HIV interventions [3,33,39].

A strength of our study lies in the fact that four very different social groups were investigated, including casual workers as a proxy for the high number of unemployed youth in Tanzania. Generalisability of the results was also enhanced through the study

design that either ensured a representative selection of participants within some groups or systematically enrolled all available members of other groups. Our results are generalisable for two populous regions of northern Tanzania. Given the similarity of findings between these regions, except for the generally higher alcohol intake in Kilimanjaro region, our findings provide an indication of what may be happening in other regions of Tanzania. A further strength of the study was the combination of different research tools to assess alcohol related variables, i.e. structured interview questions, AUDIT and DSM tests and the TLFB calendar method. This combination allowed us to triangulate results. It was reassuring that results from these different methods were consistent within sub-groups.

Limitations of our study included the cross-sectional design that precluded causal inference for factors associated with alcohol use, and the low response of women among casual workers. Responses to questions on reported alcohol use, type of alcohol consumed, amount and frequency of use and sexual behaviour may have been subject to social desirability bias. Drinking behaviour may have been underreported, but we can also not exclude that the amount of alcohol taken may have been exaggerated by some young people, e.g. out of a desire to impress interviewers. To minimise these types of bias, we ensured that interviewers and interviewees were of the same gender, that study staff were comparatively young themselves, and were trained to provide a friendly and conducive atmosphere during the interview. To minimize recall bias, we used the TLFB calendar and displays of standard alcoholic drinks. We conclude that alcohol use is common among young people in northern Tanzania, that alcohol use is highest among college students and casual labourers, and that it is associated with a number of socio-demographic and structural factors some of which might be amenable to interventions.

Apart from cultural influences such factors include alcohol use within the family, heavy exposure to alcohol advertisements and easy access to alcohol. Our study also supports observations from other studies that alcohol use may have adverse effects, including risky sexual behaviours. Alcohol use among young people is a significant public health problem in northern Tanzania and probably other parts of the country, particularly among college students and casual labourers. There is an urgent need for interventions to reduce hazardous alcohol use among young people. Such interventions should aim to address both individual factors for example, brief alcohol screening followed by motivational interviewing [40,41] and structural level factors, and multi-sectoral responses may be needed involving the education and health sectors, but also tax regulation and changes in legislation.

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Author's contribution

JF, HG and SK developed the study design, with contributions from HW and GM. JF and SK oversaw study implementation and data collection. JF and HW performed data analysis, with contributions from KB. All authors took part in the interpretation of the data. JF, HW, SK and HG drafted the article, and all authors provided critical revisions of the article for important intellectual content. JF is the guarantor of the paper.

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Supporting information

S1 Fig. This is the Recruitment flow chart among four groups of young people in northern Tanzania

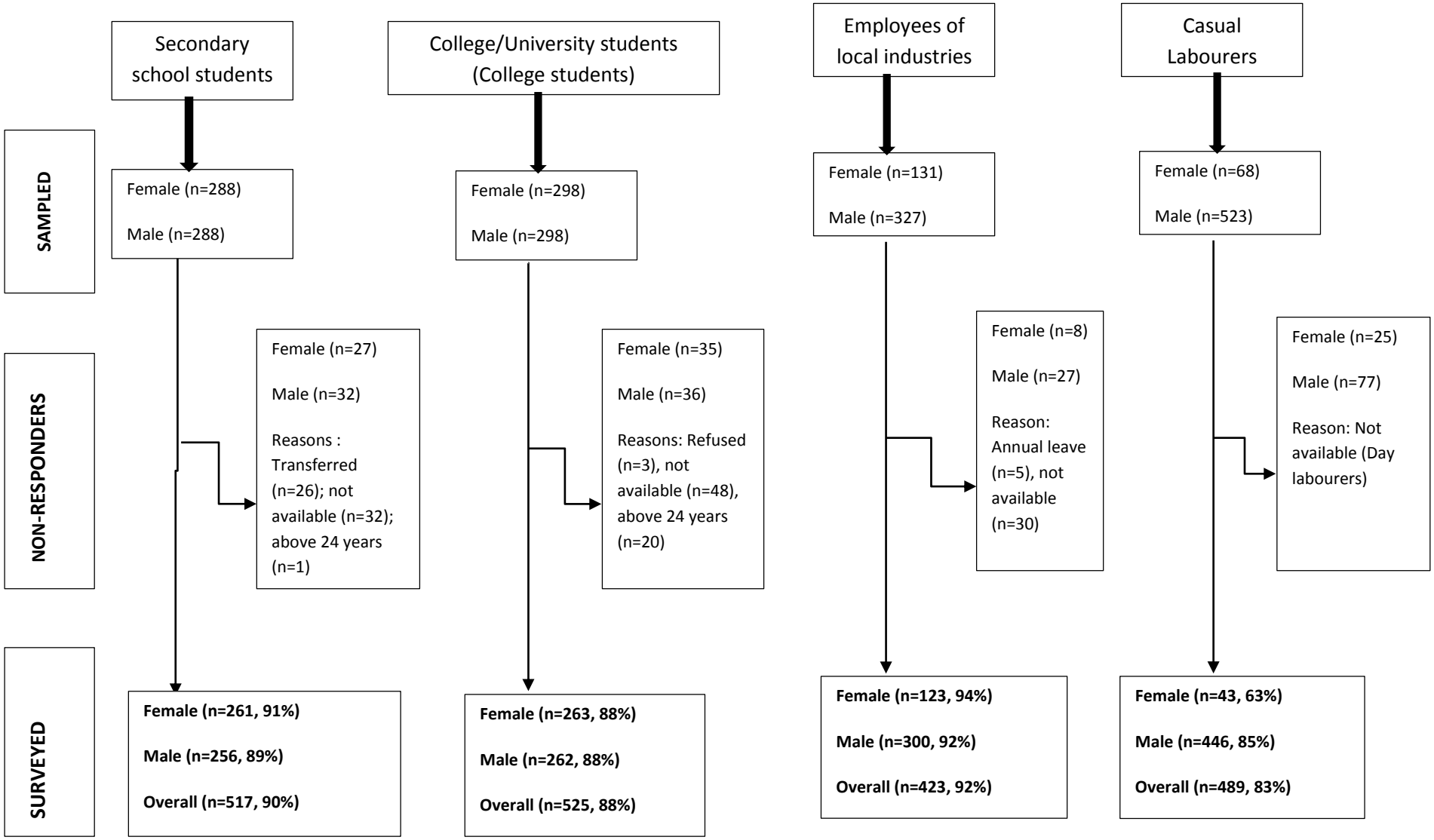
S1 Table. This is the Patterns of reported alcohol use using the Time Line Follow Back Calendar among young people who report alcohol use in the past 60 days in northern Tanzania

S2 Table. This is the Description of factors for initiation and persistence of alcohol use among young people in northern Tanzania

S1 File. This is the Alcohol Epidemiology Questionnaire (*Appendix 2*)

S2 File. This is the pictorial display of beers (*Appendix 3*)

Figure 1: This is the Recruitment flow chart among four groups of young people in northern Tanzania



Tables of results

Table 1: General characteristics of the study populations among young people in northern Tanzania

		Secondary school students		College and university students		Employed in local industries		Casual labourers	
Characteristic	**Responses**	Female	Male	Female	Male	Female	Male	Female	Male
		N (%)[1,2]	N (%)[1,2]	N (%)[1,2]	N (%)[1,2]	N (%)[1,3]	N (%)[1,3]	N (%)[1,3]	N (%)[1,3]
Total sample	N	261	256	263	262	123	300	43	446
Location	Rural	130(78.9)	132(82.1)	130(31.7)	132(37.0)	77(62.6)	134(44.7)	37(86.1)	195(43.7)
	Urban	131(21.1)	124(17.9)	133(68.3)	130(63.0)	46(37.4)	166(55.3)	6(14.0)	251(56.3)
Region	Mwanza	128(49.4)	128(42.7)	131(69.2)	130(60.7)	46(37.4)	159(53.0)	7(16.3)	231(51.8)
	Kilimanjaro	133(50.6)	128(57.3)	132(30.8)	132(39.3)	77(62.6)	141(47.0)	36(83.7)	215(48.2)
Age (years)	15-17	185(81.2)	155(74.4)	0 (0)	0 (0)	1(0.8)	6(2.0)	8(18.6)	68(15.3)
	18-20	72(17.5)	79(21.7)	30(4.8)	19(2.5)	38(30.9)	68(22.7)	16(37.2)	169(37.9)
	21-24	4(1.4)	22(3.9)	233(95.2)	243(97.5)	84(68.3)	226(75.3)	19(44.2)	209(46.9)
Religion	Muslim	52(12.2)	42(9.3)	33(10.2)	30(17.2)	23(18.7)	61(20.6)	5(11.6)	117(26.2)
	Catholic	94(39.7)	95(45.1)	102(42.4)	115(44.4)	64(52.0)	132(44.6)	26(60.5)	207(46.4)
	Protestant	115(48.1)	119(45.6)	128(47.3)	117(38.4)	36(29.3)	103(34.8)	12(27.9)	118(26.5)
	Other	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	4(1.3)	0(0.0)	4(0.9)
Education	Primary	196(88.0)	190(89.9)	0.0	0.0	61(49.6)	152(50.7)	31(72.1)	338(75.8)
	Secondary and above	65(12.1)	66(10.1)	263(100.0)	262(100.0)	62(50.4)	148(49.3)	12(27.9)	108(24.2)
Marital status	Single	215(84.5)	217(85.7)	69(32.4)	141(57.0)	35(28.5)	148(49.3)	21(48.8)	281(63.0)
	In a relationship	46(15.5)	39(14.3)	194(67.6)	121(43.0)	88(71.5)	152(50.7)	22(51.2)	165(37.0)

Disposable cash in a month	Median in USD and IQR	6.25[3.13-18.75]	9.38[3.13-15.63]	125[62.5-125]	125[59.38-156.25]	53.13[46.88-62.5]	56.25[43.75-75.00]	25.00[12.5-37.5]	37.5[18.75-62.50]
Ever had sex	Yes	27(9.4)	107(40.1)	169(66.3)	227(89.0)	103(83.7)	271(90.3)	39(90.7)	361(80.9)
Sexual intercourse last year	Yes	20(6.2)	61(20.0)	154(59.3)	195(79.3)	98(79.7)	230(76.7)	36(83.7)	297(66.6)
Number of life time sexual partners	0-1	260(99.8)	214(84.5)	205(74.9)	101(29.7)	80(65.5)	92(30.7)	20(46.5)	172(38.6)
	2 and more	1(0.2)	42(15.5)	58(25.1)	161(70.3)	43(35.0)	208(69.3)	23(53.5)	274(61.4)
Sexual partners in the last year	0-1	259(99.2)	243(95.4)	250(91.6)	206(72.0)	117(95.9)	232(77.3)	40(93.0)	307(68.8)
	2 and more	2(0.8)	12(4.6)	13(8.4)	56(28.0)	6(4.1)	68(22.7)	3(7.0)	139(31.2)
Casual sex encounter last month	None	260(99.4)	245(96.1)	259(97.7)	226(86.9)	118(95.9)	266(88.7)	40(93.0)	382(85.7)
	one and more	1(0.6)	9(3.9)	4(2.3)	36(13.1)	5(4.1)	34(11.3)	3(7.0)	64(14.3)
Condom use	Never	9(4.2)	46(19.5)	22(8.1)	18(4.5)	33(26.8)	48(16.0)	10(23.3)	91(20.4)
	sometimes	8(2.2)	17(8.5)	49(21.0)	53(31.1)	33(26.8)	74(24.7)	20(46.5)	109(24.4)
	Most of the time	10(3.0)	44(12.1)	98(37.2)	156(53.4)	37(30.1)	149(49.7)	9(20.9)	161(36.1)
	Never had sex	234(90.6)	149(59.9)	94(33.7)	35(11.0)	20(16.3)	29(9.7)	4(9.3)	85(19.1)

[1]Actual number of respondents, without sampling weights applied. [2]Proportions are weighted estimates. [3]Proportions without sampling weights applied.

Table 2: Description of potential factors related to alcohol use among young people in northern Tanzania

		Secondary school students		College and university students		Employed in local industries		Casual labourers	
Factor	**Responses**	Female	Male	Female	Male	Female	Male	Female	Male
		N (%)[1,2]	N (%)[1,2]	N (%)[1,2]	N (%)[1,2]	N (%)[1,3]	N (%)[1,3]	N (%)[1,3]	N (%)[1,3]
Total sample	N	261	256	263	262	123	300	43	446
Saw alcohol adverts in last 30 days among everyone	Never	60(31.7)	44(32.8)	5(1.0)	7(0.8)	13(10.6)	9(3.0)	1(2.3)	5(1.1)
	Sometimes	79(31.0)	74(29.6)	66(20.0)	51(20.2)	26(21.1)	90(30.0)	10(23.3)	90(20.2)
	Almost daily	122(37.4)	138(37.6)	192(79.0)	204(79.0)	84(68.3)	201(67.0)	32(74.4)	351(78.7)
Adverts in sports, social gathering and community events	Do not go	69(32.5)	48(18.0)	41(10.1)	24(5.5)	38(30.9)	58(19.3)	8(18.6)	95(21.3)
	sometimes	92(36.9)	94(40.9)	67(24.1)	82(35.4)	19(15.5)	106(35.3)	11(25.6)	158(35.4)
	Most of the time	100(30.6)	114(41.1)	155(65.8)	156(59.1)	66(53.7)	136(45.3)	24(55.8)	193(43.3)
Saw actors drinking alcohol in movies among everyone	Do not watch TV	24(12.9)	16(7.0)	4(1.4)	6(3.3)	22(17.9)	25(8.3)	8(18.6)	37(8.3)
	Sometimes	57(25.8)	57(25.5)	24(7.1)	45(19.5)	20(16.3)	81(27.0)	8(18.6)	111(24.9)
	Most of the time	180(61.3)	183(67.5)	235(91.5)	211(77.2)	81(65.9)	194(64.7)	27(62.8)	297(66.7)
Ease of obtaining alcohol	Difficult	64(35.6)	53(35.8)	2(1.3)	5(1.1)	3(2.5)	10(3.3)	2(4.7)	12(2.7)
	Easy	197(64.4)	203(64.2)	260(98.7)	257(98.9)	119(97.5)	290(96.7)	41(95.4)	434(97.3)
Taught in school about problems associated with alcohol	Yes	206(76.0)	211(78.8)	227(87.1)	230(86.4)	90(73.2)	234(78.0)	30(69.8)	307(68.8)
Brothers and sisters who drink alcohol	Yes	80(31.5)	81(30.3)	130(59.0)	130(48.6)	44(36.7)	100(33.9)	22(52.4)	183(41.6)
Perceive drinking alcohol may be harmful	Yes	260(99.2)	252(98.6)	262(99.8)	262(100.0)	121(98.4)	294(98.0)	42(97.7)	424(95.1)

[1]Actual number of respondents, without sampling weights applied. [2]Proportions are weighted estimates. [3]Proportions without sampling weights applied.

.

Table 3: Prevalence of alcohol use and alcohol use disorders (AUD) among young people in northern Tanzania

		Secondary school students[2]		College and university students[2]		Employed in local industries[3]		Casual labourers[3]	
		Female	Male	Female	Male	Female	Male	Female	Male
Total sample	**N[4]**	261	256	263	262	123	300	43	446
Ever used alcohol	Total	24.0[19.2-30.6]	47.0[37.9-55.3]	46.6[29.3-52.2]	70.4[54.8-74.2]	47.2[37.7-55.7]	50.7[39.9-63.9]	53.5[7.7-75.0]	61.0[51.4-67.7]
	Kilimanjaro	34.7[28.5-40.8]	63.9[59.0-66.1]	40.5[26.8-52.1]	67.0[50.4-74.0]	57.1[53.3-68.3]	68.1[55.3-81.8]	52.8[0.0-59.4]	70.7[60.0-76.8]
	Mwanza	12.9[8.5-16.0]	24.2[22.3-25.8]	49.3[32.7-52.2]	72.7[61.4-74.3]	30.4[18.2-50.0]	35.2[26.2-48.9]	57.1[0.0-100]	51.9[45.0-58.6]
Alcohol use in the last year	Total	11.7[5.8-17.9]	24.0[15.6-30.5]	25.5[14.4-29.1]	45.2[28.6-49.1]	24.4[15.0-34.4]	20.3[14.2-28.2]	46.5[0.0-56.7]	29.1[22.7-34.2]
	Kilimanjaro	16.6[10.4-22.6]	35.5[31.4-37.3]	21.8[12.5-29.6]	41.0[23.2-48.5]	32.5[26.3-50.0]	33.3[23.6-45.0]	50.0[0.0-56.3]	35.3[27.6-40.6]
	Mwanza	6.6[0.0-11.1]	8.6[4.7-14.4]	27.2[16.9-29.0]	48.0[37.3-49.5]	10.9[0.0-30.8]	8.8[3.8-17.5]	28.6[0.0-66.7]	23.4[16.9-29.4]
Alcohol use in the last two months	Total	2.8[1.1-5.3]	11.6[4.7-17.0]	16.5[7.9-19.2]	26.8[20.2-39.1]	11.4[6.3-18.3]	13.7[8.5-21.2]	30.2[0.0-36.6]	18.2[11.7-22.7]
	Kilimanjaro	5.2[2.5-7.8]	19.0[11.5-22.3]	13.7[6.3-19.9]	33.6[17.3-40.6]	16.9[10.7-30.0]	23.4[14.1-35.1]	33.3[0.0-37.5]	24.7[17.8-29.6]
	Mwanza	0.4[0.0-1.3]	1.8[0.0-4.6]	17.8[10.6-19.0]	22.5[20.8-33.8]	0	5.0[0.0-10.7]	14.3[0.0-28.6]	12.1[7.2-16.8]
Alcohol use in the last month	Total	0.9[0.1-2.0]	6.6[4.7-8.0]	13.3[7.4-15.1]	25.3[19.5-35.9]	7.3[3.1-12.9]	12.7[7.9-19.1]	27.9[0.0-33.8]	16.1[9.9-21.0]
	Kilimanjaro	1.4[0.2-2.5]	10.5[10.0-11.5]	10.1[6.0-13.4]	31.0[14.4-38.0]	11.7[5.6-25.0]	21.3[12.8-32.3]	30.6[0.0-34.4]	22.8[15.6-28.0]
	Mwanza	0.4[0.0-1.3]	1.3[0.0-3.4]	14.7[9.6-15.6]	21.6[20.7-28.0]	0	5.0[0.0-10.7]	14.3[0.0-28.6]	10.0[4.6-14.6]
Alcohol use disorders (AUD)	Total	0.3[0.0-0.7]	10.6[3.8-16.6]	6.5[2.3-9.8]	27.5[13.6-30.9]	1.6[0.0-3.3]	6.0[2.8-10.7]	7.0[0.0-9.1]	13.7[8.0-18.3]
	Kilimanjaro	0.1[0.0-0.3]	18.4[10.3-22.1]	6.3[0.0-11.6]	20.9[8.0-26.7]	2.6[0.0-6.7]	8.5[4.5-12.9]	8.3[0.0-9.4]	14.9[6.7-20.8]
	Mwanza	0.4[0.0-1.3]	0	6.5[5.6-6.7]	31.7[22.5-33.0]	0	3.8[0.0-12.5]	0	12.6[7.6-17.0]
Alcohol dependence[1]	Total	0.3[0.0-0.7]	5.5[1.4-9.3]	3.8[1.1-6.9]	4.2[2.2-8.1]	0.8[0.0-2.0]	1.0[0.0-2.6]	0	5.4[2.0-8.4]
	Kilimanjaro	0.1[0.0-0.3]	9.6[3.7-12.3]	4.9[0.0-9.4]	5.1[1.1-7.2]	1.3[0.0-2.8]	1.4[0.0-3.8]	0	7.9[2.2-12.0]
	Mwanza	0.4[0.0-1.3]	0	3.3[2.7-3.4]	3.6[2.5-11.1]	0	0.6[0.0-2.2]	0	3.0[1.0-4.8]

[1]AUD defined as AUDIT score $\geq$8, Alcohol dependence by DSM IV criteria ($\geq$3 symptoms). [2]Prevalences and confidence intervals are weighted estimates, adjusted for survey design with sampling weights applied. [3]Standard errors are adjusted for the survey design but without sampling weights applied. [4]Actual number of respondents, without sampling weights applied.

Table 4: Factors associated with reported ever use of alcohol among young people in northern Tanzania

		Secondary school students			College and university students			Employed in local industries			Casual labourers		
Variables	**Categories**	Number reporting ever use (n=164)	Crude estimates	Adjusted estimates	Number reporting ever use (n=280)	Crude estimates	Adjusted estimates	Number reporting ever use (n=210)	Crude estimates	Adjusted estimates	Number reporting ever use(n=295)	Crude estimates	Adjusted estimates
			OR (95%CI)	AOR[1] (95%CI)		OR (95%CI)	AOR[2] (95%CI)		OR (95%CI)	AOR[3] (95%CI)		OR (95%CI)	AOR[4] (95%CI)
Area	Rural	78(29.8)	1	1	120(45.8)	1	1	118(52.9)	1	1	168(64.4)	1	1
	Urban	86(33.7)	0.83[0.46-1.68]	1.70[1.06-5.22]	160(60.8)	1.54[0.65-3.25]	1.95[0.92-2.79]	92(46.0)	0.76[0.43-2.11]	0.85[0.51-2.31]	127(55.7)	0.70[0.44-1.66]	0.67[0.42-1.53]
Region	Mwanza	53(20.7)	1	1	130(49.8)	1	1	70(34.2)	1	1	124(52.1)	1	1
	Kilimanjaro	111(42.5)	4.61[3.07-6.37]	4.36[2.71-9.21]	150(56.8)	0.82[0.36-2.31]	0.77[0.49-1.89]	140(64.2)	3.46[1.75-6.17]	5.28[2.62-11.61]	171(68.1)	1.97[0.99-3.01]	3.53[1.73-5.58]
Sex	Female	63(24.1)	1	1	111(42.2)	1	1	58(47.2)	1	1	23(53.5)	1	1
	Male	101(39.5)	2.81[2.12-3.36]	3.18[2.64-4.66]	169(64.5)	2.73[2.60-3.09]	4.00[2.39-5.17]	152(50.7)	1.15[0.75-2.08]	1.25[0.66-2.62]	272(61.0)	1.36[0.56-12.27]	2.67[0.28-30.27]
Age	15-19	136(30.0)	1	1	5(41.7)	1	1	22(37.9)	1	1	98(50.3)	1	1
	20-24	28(43.8)	1.73[1.11-2.63]	1.06[0.75-2.03]	275(53.6)	1.31[0.44-1.33]	0.64[0.26-0.64]	188(51.5)	1.74[1.12-3.89]	1.66[0.98-3.26]	197(67.0)	2.01[1.34-2.93]	1.59[0.78-2.46]
Marital status	Single	116(24.1)	1	1	100(47.6)	1	1	76(41.5)	1	1	169(56.0)	1	1
	In relationship	48(56.5)	4.72[2.91-6.27]	4.29[2.35-8.88]	180(57.1)	2.06[1.20-2.58]	2.65[1.12-3.84]	134(51.9)	1.78[1.12-2.91]	1.84[1.07-3.66]	126(67.4)	1.63[1.33-2.16]	1.26[0.93-1.84]
Disposable cash in a month	Below median for the group	69(24.7)	1	1	131(43.1)	1	1	100(47.4)	1	1	140(56.2)	1	1
	Above median for the group	95(39.9)	2.80[1.18-4.56]	1.78[1.31-5.12]	149(67.4)	2.28[1.31-9.20]	2.14[1.00-10.82]	110(51.9)	1.2[0.78-2.04]	0.88[0.40-1.61]	155(64.6)	1.42[1.11-2.06]	1.24[0.73-2.13]
Siblings drink alcohol	No	76(21.4)	1	1	106(40.0)	1	1	125(44.8)	1	1	145(51.1)	1	1
	Yes	88(54.7)	4.31[3.46-5.30]	3.95[2.74-7.31]	174(66.9)	2.26[1.67-4.63]	1.81[1.16-4.29]	85(59.0)	1.77[1.15-2.81]	1.54[0.83-2.81]	150(73.2)	2.61[1.53-3.60]	1.87[0.95-2.75]

Religion	Muslim	18(19.5)	1	1	21(33.3)	1	1	38(45.2)	1	1	60(49.2)	1	1
	Catholic	74(39.2)	2.56[0.74-4.92]	2.73[1.09-4.99]	135(62.2)	4.61[1.76-7.08]	6.36[1.39-12.50]	110(56.1)	1.55[0.93-2.44]	2.02[1.20-4.04]	165(70.8)	2.51[1.36-4.31]	2.58[1.56-5.00]
	Protestants	72(30.8)	1.79[1.00-2.85]	2.06[0.83-3.1]	124(50.6)	2.50[0.70-4.61]	3.25[0.63-7.09]	61(43.9)	0.95[0.59-1.40]	1.01[0.53-1.66]	68(52.3)	1.13[0.57-1.96]	1.08[0.45-2.07]
Life time sexual partners	0-1	135(28.5)	1	1	123(40.2)	1	1	71(41.3)	1	1	86(44.8)	1	1
	2 and more	29(67.4)	6.46[3.93-15.08]	2.21[1.15-9.67]	157(71.7)	3.49[3.17-4.11]	1.68[1.27-3.43]	139(55.4)	1.77[1.14-3.63]	2.69[1.65-5.49]	209(70.4)	2.93[2.25-4.38]	3.10[2.15-5.40]

All OR and AOR are adjusted for the survey design. AOR[1]- adjusted for location, sex, age, marital status, income, having siblings who drink alcohol, religion and number of lifetime partners. AOR[2]- adjusted for location, sex, marital status, disposable cash, having siblings who drink alcohol, religion and number of life time partners. AOR[3]- adjusted for location, sex, age, marital status, disposable cash, having siblings who drink alcohol, religion and number of lifetime partners. AOR[4] -adjusted for location, sex, age, marital status, disposable cash, having siblings who drink alcohol, religion and number of life time partners

Table 5: Factors associated with reported alcohol use in the last year among young people in northern Tanzania

		Secondary school students			College and university students			Employed in local industries			Casual labourers		
Variables	**categories**	Number reporting use in the last year(n=81)	Crude estimates OR (95%CI)	Adjusted estimates AOR[1] (95%CI)	Number reporting use in the last year(n=164)	Crude estimates OR (95%CI)	Adjusted estimates AOR[2] (95%CI)	Number of reporting use in the last year(n=91)	Crude estimates OR (95%CI)	Adjusted estimates AOR[3] (95%CI)	Number reporting use in the last year(n=150)	Crude estimates OR (95%CI)	Adjusted estimates AOR[4] (95%CI)
Area	Rural	39(14.9)	1	1	67(25.6)	1	1	53(23.8)	1	1	92(35.3)	1	1
	Urban	42(16.5)	0.75[0.38-1.73]	1.15[0.59-2.99]	97(36.9)	1.43[0.64-3.29]	1.62[0.66-3.56]	38(19.0)	0.75[0.38-2.12]	1.1[0.43-3.13]	58(25.4)	0.63[0.44-1.49]	0.66[0.40-1.20]
Location	Mwanza	24(9.4)	1	1	78(29.9)	1	1	19(9.3)	1	1	56(23.5)	1	1
	Kilimanjaro	57(21.8)	4.62[2.42-6.62]	3.90[2.10-7.22]	86(32.6)	0.82[0.33-1.93]	0.69[0.29-2.14]	72(33.0)	4.83[1.90-11.59]	5.06[1.87-14.74]	94(37.5)	1.95[1.01-3.14]	2.37[1.34-4.22]
Gender	Female	33(12.6)	1	1	64(24.3)	1	1	30(24.4)	1	1	20(46.5)	1	1
	Male	48(18.8)	2.39[1.44-5.08]	2.40[1.54-4.93]	100(38.2)	2.41[2.31-2.66]	3.86[2.74-4.32]	61(20.3)	0.79[0.50-1.30]	1.02[0.43-2.16]	130(29.2)	0.47[0.03-2.90]	0.49[0.19-3.71]
Age	15-19	70(15.5)	1	1	2(16.7)	1	1	12(20.7)	1	1	47(24.1)	1	1
	20-24	11(17.20	1.25[0.82-2.07]	0.71[0.37-1.80]	162(31.6)	2.05[0.81-2.18]	1.74[0.61-1.13]	79(21.6)	1.06[0.69-2.68]	1.46[0.50-3.08]	103(35.0)	1.7[1.13-2.23]	1.37[0.63-2.00]
Marital status	Single	52(12.0)	1	1	55(26.2)	1	1	36(19.7)	1	1	75(24.8)	1	1
	In relationship	29(34.1)	5.12[2.77-6.19]	3.55[1.81-4.98]	109(34.6)	1.75[1.14-1.97]	2.16[1.42-2.79]	55(22.9)	1.21[0.82-2.34]	1.25[0.86-2.08]	75(40.1)	2.03[1.50-2.72]	1.69[0.97-2.42]
Disposable cash in a month	Below median for the group	29(10.4)	1	1	73(24.0)	1	1	43(20.4)	1	1	64(25.7)	1	1
	Above median for the group	52(21.9)	3.86[1.45-8.37]	2.23[1.32-7.67]	91(41.2)	1.64[0.94-4.55]	1.37[0.73-4.44]	48(22.6)	1.14[0.51-2.96]	0.99[0.51-2.13]	86(35.8)	1.61[1.15-3.91]	1.60[0.99-4.88]
Brothers and sisters drink alcohol	No	36(10.1)	1	1	46(17.4)	1	1	47(16.9)	1	1	69(24.3)	1	1
	Yes	45(28.0)	3.23[2.12-5.72]	2.58[1.98-3.53]	118(45.4)	3.81[3.04-6.59]	3.76[2.98-5.85]	44(30.6)	2.17[1.45-3.24]	2.02[1.29-3.08]	81(39.5)	2.04[1.27-2.92]	1.73[1.20-2.85]

Religion	Muslim	12(12.8)	1	1	10(15.9)	1	1	11(13.1)	1	1	33(27.1)	1	1
	Catholic	41(21.7)	1.39[0.28-2.49]	1.27[0.37-3.06]	93(42.9)	5.25[3.63-5.93]	4.56[2.95-5.81]	59(30.1)	2.86[1.55-6.77]	2.91[1.71-7.23]	87(37.3)	1.61[0.82-2.44]	1.41[0.82-2.30]
	Protestants	28(12.0)	0.55[0.31-0.97]	0.55[0.31-0.63]	61(24.9)	2.22[0.99-3.30]	1.83[0.88-2.97]	21(15.1)	1.18[0.58-2.51]	1.26[0.62-2.79]	29(22.3)	0.77[0.36-1.39]	0.65[0.27-1.17]
Sexual partners last year	0-1	72(14.3)	1	1	121(26.5)	1	1	73(20.9)	1	1	84(24.2)	1	1
	2 and more	8(57.1)	18.61[8.27-70.01]	9.85[3.05-137.3]	43(62.3)	3.23[2.66-5.83]	1.53[1.13-3.70]	18(24.3)	1.22[0.80-1.69]	1.24[0.83-1.79]	66(46.5)	2.72[1.91-4.42]	2.83[1.79-4.41]

All OR and AOR are adjusted for the survey design. AOR[1]- adjusted for location, sex, marital status, disposable cash, having siblings who drink alcohol, religion and number of last year sexual partners. AOR[2]- adjusted for location, sex, disposable cash, having siblings who drink alcohol, religion and number of last year sexual partners. AOR[3]- adjusted for location, sex, disposable cash, having siblings who drink alcohol, religion and number of last year sexual partners.AOR[4]- adjusted for location, sex, age, marital status, disposable cash, having siblings who drink alcohol, religion and number of last year sexual partners.

Table 6: Factors associated with Alcohol Use Disorders (AUDIT score ≥8) among young males in northern Tanzania

Variables	Categories	Secondary school students[3]		College and university students			Employed in local industries[3]		Casual labourers		
		Number screened positive for AUD (n=15)	Crude estimates OR (95%CI)	Number screened positive for AUD (n=53)	Crude estimates OR (95%CI)	Adjusted estimates AOR[1] (95%CI)	Number screened for AUD (n=18)	Crude estimates OR (95%CI)	Number screened for AUD (n=61)	Crude estimates OR (95%CI)	Adjusted estimates AOR[2] (95%CI)
Area	Rural	12(9.1)	1	18(13.6)	1	1	14(10.0)	1	40(17.9)	1	1
	Urban	3(2.4)	0.1[0.10-0.69]	35(26.9)	1.85[0.89-7.99]	1.33[0.75-4.71]	4(2.5)	0.23[0.08-1.01]	21(9.4)	0.48[0.26-1.53]	0.47[0.21-1.62]
Location	Mwanza	0(0.4)		29(22.3)	1	1	6(3.8)	1	29(12.6)	1	1
	Kilimanjaro	15(11.7)		24(18.2)	0.57[0.18-1.25]	0.51[0.17-1.11]	12(8.5)	2.37[0.51-16.73]	32(14.9)	1.22[0.39-2.59]	1.91[0.53-4.67]
Marital status	Single	8(3.7)	1	20(14.2)	1	1	11(7.4)	1	25(8.9)	1	1
	In relationship	7(18.0)	9.78[4.15-14.35]	33(27.3)	1.78[1.16-2.00]	1.42[0.78-1.48]	7(4.6)	0.60[0.26-1.55]	36(21.8)	2.86[1.76-7.13]	1.70[0.87-4.27]
Disposable cash in a month	Below median for the group	1(0.7)	1	21(13.8)	1	1	8(5.4)	1	17(7.7)	1	1
	Above median for the group	14(12.4)	19.85[4.33-8.09]	32(29.1)	0.90[0.35-8.41]	0.66[0.21-7.68]	10(6.5)	1.22[0.32-5.73]	44(19.6)	2.95[1.73-14.50]	2.18[1.19-17.91]
Brothers and sisters drink alcohol	No	7(4.0)	1	17(12.9)	1	1	9(4.5)	1	24(9.1)	1	1
	Yes	8(9.9)	2.56[1.88-7.77]	36(27.7)	2.59[2.29-4.34]	2.50[2.33-4.28]	9(9.0)	2.10[0.77-4.01]	37(20.2)	2.52[1.20-4.31]	2.14[1.00-4.62]
Sexual partners last year	0-1	9(3.7)	1	31(15.1)	1	1	12(5.2)	1	22(7.2)	1	1
	2 and more	5(41.7)	37.1[21.13-225.47]	22(39.3)	2.17[1.07-4.04]	1.46[0.77-2.72]	6(8.8)	1.77[0.59-3.56]	39(28.1)	5.05[2.98-17.36]	3.97[2.33-16.63]

All OR and AOR are adjusted for the survey design. AOR[1]-adjusted for location, marital status, having siblings who drink alcohol and number of sexual partners in the last year. AOR[2]-adjusted for location, age, marital status, having siblings who drink alcohol and number of sexual partners in the last year.[3] No AORs for secondary school students and local industry employees due to small numbers of individuals who screened positive for AUD

Table 7: **Patterns of alcohol use among young people reported alcohol use in the last year in northern Tanzania**

		Secondary school students[2]		College students[2]		Local industries employees[3]		Casual labourers[3]	
Variables	**Responses**	Female	Male	Female	Male	Female	Male	Female	Male
Sample	N[1]	33	48	64	100	30	61	20	130
All who had a drink in the last year	Median days drinking in a week	0[0-0]	1[1-2]	2[1-2]	2[1-2]	1[1-1]	1[1-2]	2[1-3]	2[1-2]
	Drinks per day-median	2.0[1.0-6.0]	4.0[3.0-8.0]	6.0[2.0-6.0]	9.0[6.0-12.0]	2.0[1.0-4.0]	6.0[3.0-9.0]	3.0[1.0-4.0]	6.0[2.0-9.0]
Usual drink among last year drinkers	Bottled beer	32.4[0.0-48.5]	23.7[17.3-27.0]	46.8[40.2-88.5]	60.1[20.1-83.9]	43.3[26.1-66.7]	47.5[28.0-59.7]	40.0[0.0-100]	43.9[29.5-60.8]
	Wine	22.8[11.8-41.6]	0.9[0.0-2.6]	25.3[1.6-31.8]	1.1[0.2-5.9]	6.7[0.0-23.5]	0	0	0
	Spirit/liquor	9.1[1.0-17.3]	26.3[22.0-28.2]	0.9[0.0-5.8]	3.0[0.0-8.0]	0	11.5[2.3-22.5]	0	10.8[6.2-15.1]
	Local beer/spirit/liquor	16.7[0.7-69.7]	24.9[16.3-46.9]	0	0.6[0.0-4.9]	33.3[0.0-54.8]	13.1[3.4-22.6]	35.0[0.0-38.9]	13.1[2.5-19.6]
	Other	1.8[0.0-4.9]	0	1.2[0.6-5.2]	0	0	0	0	0
	more than one type	17.3[0.0-32.2]	24.3[8.2-32.4]	25.8[1.9-39.7]	35.1[14.7-69.9]	16.7[6.1-25.0]	27.9[18.2-44.2]	25.0[0.0-27.8]	32.3[22.7-40.1]
Drink alcohol	Monthly or less	96.4[90.2-100]	82.1[77.9-90.9]	69.4[66.3-86.7]	55.2[49.3-64.8]	93.3[84.6-100]	78.7[69.5-89.8]	75.0[0.0-100.0]	66.9[57.2-81.4]
	2-4 times a month	3.6[0.0-9.8]	13.8[9.1-18.1]	17.1[4.5-21.2]	31.9[23.9-36.4]	3.3[0.0-12.5]	16.4[5.7-25.7]	15.0[0.0-16.7]	23.1[8.9-33.3]
	2 and more times a week	0	4.1[0.0-6.3]	13.5[5.6-24.8]	13.0[9.8-14.3]	3.3[0.0-8.2]	4.9[0.0-11.4]	10.0[0.0-11.1]	10.0[4.2-13.0]
Standard drinks in a typical day	1 or 2	56.4[34.8-97.8]	25.6[12.7-57.4]	32.3[7.9-40.2]	6.2[1.4-14.1]	53.3[21.6-76.5]	19.7[10.0-30.4]	45.0[0.0-50.0]	27.1[18.1-34.9]
	3 or 4	15.4[0.0-24.3]	31.3[8.0-40.9]	9.3[2.9-44.7]	13.7[11.7-26.0]	26.7[3.6-50.9]	32.8[21.1-47.9]	30.0[0.0-100.0]	16.3[5.7-24.7]
	5 or 6	26.0[0.0-48.2]	6.4[0.0-8.9]	37.2[18.0-43.9]	16.0[9.7-18.6]	13.3[0.0-23.5]	23.0[10.8-34.4]	10.0[0.0-11.1]	12.4[7.7-18.4]
	Above 6[4]	2.3[0.0-6.2]	36.7[26.8-41.4]	21.2[9.7-51.7]	64.1[47.8-69.2]	6.7[0.0-25.0]	24.6[12.3-35.1]	15.0[0.0-100.0]	44.2[38.5-52.4]

Occasions with six or more drinks	Never	58.8[50.1-72.3]	36.9[24.4-61.4]	31.2[16.6-38.6]	8.7[2.5-20.9]	56.7[28.6-76.5]	34.4[21.6-50.0]	60.0[0.0-100.0]	39.5[30.0-48.0]
	Less than monthly	31.9[24.4-49.6]	52.0[30.3-63.0]	47.1[42.9-59.3]	54.1[38.8-56.5]	40.0[23.4-69.2]	50.8[32.2-68.6]	35.0[0.0-100.0]	38.0[28.3-53.3]
	Monthly	7.5[0.0-16.1]	4.3[0.0-6.4]	10.4[0.0-12.2]	25.6[22.7-27.0]	0	4.9[0.0-10.7]	0	8.5[0.0-16.2]
	Weekly	1.8[0.0-4.9]	6.8[5.6-9.9]	11.3[5.6-14.9]	11.6[5.8-16.1]	3.3[0.0-8.2]	9.8[2.1-16.0]	5.0[0.0-5.6]	14.0[7.8-17.7]

[1]Actual number of respondents without sampling weights applied. [2]Weighted estimates. [3]Estimates without sampling weights applied. [4]Heavy episodic drinking is defined as average of 6 or more standard drinks in a drinking occasion

S1 Table: Patterns of reported alcohol use using the Time Line Follow Back Calendar among young people who report alcohol use in the past 60 days in northern Tanzania

		Secondary school students[2]		College and university students[2]		Employed in local industries[3]		Casual labourers[3]	
Variables	Responses	Female	Male	Female	Male	Female	Male	Female	Male
Sample	N[1]	9	20	41	72	14	41	13	81
Time line follwoback calendar 60 days	Events-median &IQR	2[1-2]	4[2-7]	1[1-5]	5[2-8]	1[1-3]	4[2-6]	6[4-10]	6[3-10]
	Drinks in 60 days-median &IQR	2.5[1.3-9.0]	20.0[3.5-49.0]	6[2-36]	39.8[12-62.6]	0.8[0.3-12.0]	21.0[6.0-44.0]	18.0[8.0-30.0]	40.8[12.5-73.6]
	Drinks in 30 days-median&IQR	1.3[0.6-4.5]	10.0[1.8-24.5]	3[1-18]	19.9[6-31.3]	0.4[0.2-6.0]	10.5[3.0-22.0]	9.0[4.0-15.0]	20.4[6.2-36.8]
	Drinks per event-median&IQR	1.3[1.3-4.5]	4.0[2.2-6.0]	4.2[2.0-6.0]	7.5[4.9-9.8]	1.0[0.3-4.0]	6.0[3.5-8.3]	3.3[1.0-4.0]	6.8[2.8-9.4]
	Days drinking in a month-median	1[1-1]	2[1-4]	1[1-3]	2[1-4]	1[1-2]	2[1-3]	3[2-5]	3[2-5]
	Heavy episodic drinking[4] (%, 95%CI)	7.5[0-25.4]	26.7[0.0-33.0]	26.3[14.9-55.0]	71.2[51.0-91.1]	7.1[0.0-25.0]	51.2[36.7-66.7]	7.7[0.0-8.3]	56.8[47.8-71.2]

. [1]Actual number of respondents without sampling weights applied. [2]Median are weighted estimates. [3]Median without sampling weights applied. [4]Heavy episodic drinking is defined as average of 6 or more standard drinks in a drinking occasion

S 2 Table: Description of factors for initiation and persistence of alcohol use among young people in northern Tanzania

		Secondary school students[4]		College and university students[4]		Employed in local industries[5]		Casual labourers [5]	
Variables	Responses	Female	Male	Female	Male	Female	Male	Female	Male
Sample	N[1]	63	101	111	169	58	152	23	272
First drinking occasion among ever users	Holiday(festivity/recreation)	23.6[18.4-28.6]	20.1[16.6-25.8]	22.4[17.1-28.3]	21.9[17.6-24.2]	22.4[13.7-37.9]	30.9[26.2-36.0]	26.1[0.0-30.8]	37.5[33.3-41.2]
	Wedding	3.8[0.0-7.8]	13.4[4.0-29.2]	15.7[7.3-18.5]	9.2[0.8-10.9]	8.6[2.8-16.0]	7.2[2.8-12.5]	17.4[0.0-50.0]	8.1[5.0-10.7]
	School party	6.9[0.0-11.8]	1.2[0.0-3.7]	5.2[4.5-7.5]	19.1[8.2-25.2]	6.9[0.0-11.2]	2.6[0.6-5.1]	4.3[0.0-5.1]	2.9[0.8-5.1]
	Party with friends	7.6[1.7-13.8]	3.0[0.0-7.9]	7.7[6.0-10.3]	6.5[0.4-7.6]	6.9[0.0-18.6]	4.6[1.3-7.9]	8.7[0.0-100]	4.0[1.5-6.6]
	Other family celebration	17.3[7.3-32.7]	33.6[31.0-36.8]	13.5[10.3-24.6]	11.5[9.8-11.8]	20.7[11.0-37.0]	16.4[11.0-22.2]	17.4[0.0-20.5]	16.2[10.7-19.9]
	Not a special occasion	25.9[16.7-34.8]	23.4[3.6-35.4]	20.7[18.5-31.4]	25.7[16.0-43.4]	22.4[8.7-28.4]	32.9[26.0-39.0]	21.7[0.0-25.6]	23.2[18.9-28.8]
	Other	7.2[2.4-12.0]	3.1[1.0-7.6]	5.4[2.7-7.2]	2.2[0.7-3.0]	3.4[0.0-11.1]	4.6[1.0-8.0]	4.3[0.0-100.0]	4.8[2.3-8.8]
Drink at first occasion among ever users	Bottled beer	30.9[12.1-43.6]	40.5[20.5-48.5]	59.7[56.6-69.9]	66.0[52.0-68.8]	51.7[39.0-69.0]	55.3[48.0-63.2]	34.8[21.1-100.0]	47.8[38.8-60.9]
	Wine	4.9[0.0-12.5]	1.0[0.5-1.8]	19.9[7.5-24.2]	7.5[0.9-9.8]	6.9[0.0-16.7]	1.3[0.0-3.0]	0.0	0.0
	Spirit/liqour	5.6[0.5-10.0]	13.0[7.1-15.7]	1.9[0.0-10.8]	7.4[4.7-12.3]	0.0	11.8[7.3-17.0]	0.0	10.7[7.7-15.6]
	Local beer/spirit/liquor	44.5[30.5-66.4]	31.8[17.8-67.2]	13.8[6.1-16.2]	17.7[16.6-23.8]	36.2[20.0-48.1]	27.6[18.1-37.4]	39.1[0.0-46.2]	31.6[18.2-39.4]
	Other	1.6[0.0-4.2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	More than one type	12.6[10.4-14.9]	13.7[2.8-20.4]	4.6[1.0-16.2]	1.5[0.1-9.1]	5.2[0.0-10.3]	3.9[0.0-7.7]	26.1[0.0-30.8]	9.9[6.3-12.2]
Reason for drinking at first occasion among ever users	Wanted to try	51.8[44.7-58.0]	43.9[41.6-48.6]	33.0[27.1-49.6]	48.8[36.4-53.8]	44.8[31.5-61.5]	36.2[29.1-44.5]	60.9[0.0-100.0]	35.3[31.5-39.6]
	Convinced by a friend	0.4[0.2-0.7]	18.9[15.4-22.4]	2.5[0.0-9.7]	16.3[1.4-24.6]	0.0	17.1[10.0-24.2]	0.0	12.9[8.8-19.8]

	Advice from parents/relatives	4.1[0.0-8.5]	8.1[4.2-11.0]	14.2[1.3-16.5]	5.0[3.2-9.5]	3.4[0.0-8.2]	7.2[1.8-11.3]	0.0	3.3[1.0-6.3]
	Convinced by a partner					0.0	0.7[0.0-1.9]	0.0	0.4[0.0-0.6]
	other	0.1[0.0-0.4]	0	1.1[0.2-6.7]	2.3[0.7-8.9]	1.7[0.0-5.1]	1.3[0.0-3.8]	0.0	1.5[0.0-3.9]
	more than one reason	43.6[33.5-54.1]	29.1[25.0-33.6]	49.2[42.9-50.4]	27.6[17.0-48.9]	50.0[35.8-64.1]	37.5[23.9-48.7]	39.1[0.0-100.0]	46.7[36.1-53.1]
	N[2]	198	155	152	93	68	148	20	174
Reasons for not drinking among those never used alcohol	Parents	91.4[87.4-93.9]	91.0[87.0-95.8]	73.3[67.3-76.5]	85.7[77.4-89.8]	76.9[65.7-88.1]	65.0[58.6-73.2]	44.4[25.0-100.0]	74.7[68.5-80.5]
	Relatives	74.9[69.7-78.5]	51.5[41.6-67.4]	40.5[36.4-48.1]	45.9[43.2-52.4]	52.3[35.9-67.3]	51.4[42.5-60.2]	11.1[0.0-100.0]	60.0[53.2-67.2]
	Religion	59.6[54.0-66.0]	69.5[60.3-77.7]	67.1[60.4-70.3]	92.8[78.0-98.7]	60.0[49.3-79.8]	62.9[52.0-70.5]	33.3[0.0-100.0]	68.2[64.1-72.8]
	Friends	60.1[55.9-63.1]	39.9[32.6-49.6]	31.6[28.5-38.0]	38.3[26.7-43.1]	43.1[26.3-56.0]	37.9[26.7-46.0]	11.1[0.0-100.0]	33.5[26.0-42.3]
	Afraid of side effects	91.6[88.3-94.3]	93.1[90.9-95.4]	92.7[90.8-96.8]	97.6[91.6-100.0]	95.4[91.8-100.0]	92.1[84.5-97.2]	88.9[81.8-100.0]	91.2[87.1-95.2]
	N[3]	30	53	47	69	28	91	3	142
Reasons for not drinking in the past 12 months among ever users	Parents	60.2[38.9-81.4]	78.6[71.6-85.4]	63.3[47.2-66.8]	45.9[41.5-63.9]	60.7[25.8-72.4]	50.5[37.0-61.3]	66.7[0.0-100.0]	66.2[59.6-73.0]
	Relatives	51.5[38.0-61.7]	45.9[35.0-65.9]	17.3[15.1-24.0]	25.6[19.1-34.8]	28.6[0.0-37.1]	26.4[16.7-34.3]	33.3[0.0-100.0]	45.1[37.5-53.5]
	Religion	34.5[1.8-58.7]	62.9[57.0-73.1]	53.9[45.9-63.9]	44.8[28.7-76.1]	42.9[23.1-66.1]	57.0[46.2-66.0]	66.7[0.0-100.0]	51.4[40.3-57.6]
	I have no money	30.6[13.9-47.9]	4.7[2.0-7.9]	2.2[0.0-9.4]	5.5[0.0-8.4]	0.0	4.0[0.0-7.9]	0.0	5.6[2.9-8.7]
	Dislike alcohol	67.8[55.7-80.9]	85.4[81.5-91.8]	85.0[64.6-91.3]	99.2[96.0-100.0]	85.7[71.4-100.0]	87.9[79.8-93.8]	66.7[0.0-100.0]	87.3[78.8-94.0]
	Being at home	30.7[16.8-43.0]	22.2[7.8-41.2]	5.1[0.0-21.2]	2.0[0.0-9.9]	17.9[0.0-33.3]	6.6[1.6-10.2]	0.0	5.6[0.5-8.1]
	Being at college	17.9[12.3-25.3]	23.2[18.2-35.1]	1.6[0.0-9.3]	7.3[1.9-17.6]	0.0	0.0	0.0	0.0
	I have health problems	7.0[0.0-16.8]	9.5[6.0-17.6]	6.0[0.0-8.0]	4.8[0.0-14.0]	7.1[0.0-16.0]	6.6[3.2-10.8]	0.0	10.6[6.6-14.0]

	I am afraid of side effect	12.0[0.0-28.0]	23.0[15.0-33.9]	6.8[2.3-27.4]	35.1[14.3-46.3]	10.7[0.0-33.3]	29.7[23.5-37.6]	33.3[0.0-100.0]	23.9[19.0-34.2]
	Other	13.5[4.0-20.8]	9.3[0.0-22.5]	12.1[7.8-13.5]	6.1[0.7-17.3]	21.4[10.1-60.8]	24.2[12.9-34.4]	33.3[0.0-100.0	19.0[12.8-23.8]

[1] Actual number of respondents ever used alcohol without sampling weights applied. [2]Actualnumber of respondents never used alcohol without sampling weights applied. [3] Actual number of respondents drunk alcohol in the last year among ever users without sampling weights applied. [4]Proportions are weighted estimates. [5]Proportions without sampling weights applied.

Chapter 5. The validity of self-reported alcohol use compared with the alcohol biomarker phosphatidylethanol among young people in northern Tanzania

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SECTION A – Student Details

Student	Joel Msafiri Francis
Principal Supervisor	Heiner Grosskurth
Thesis Title	EPIDEMIOLOGY OF ALCOHOL USE AND ALCOHOL USE DISORDERS (AUD) AMONG YOUNG PEOPLE IN NORTHERN TANZANIA

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
When was the work published?			
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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	Drug and Alcohol Dependence journal
Please list the paper's authors in the intended authorship order:	Joel M Francis, Helen A Weiss, Anders Helander, Saidi H Kapiga, John Changalucha, Heiner Grosskurth
Stage of publication	**Undergoing revision**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I developed the study design with inputs from Helen Weiss, Heiner Grosskurth, Saidi Kapiga and Anders Helander. I oversaw the study implementation and data collection. Anders Helander perfomed Phosphatidylethanol assays at the Karolinska university laboratory. I performed data

	analysis with inputs from Helen Weiss and Heiner Grosskurth. I interpreted the results and drafted the article and then all co-authors provided critical comments on the interpretation of the data and the draft article. I am the guarantor of the paper.

Student Signature: Yusafiri **Date:** 30. 07. 2015

Supervisor Signature: [signature] **Date:** 30.7.2015

The validity of self-reported alcohol use compared with the alcohol biomarker phosphatidylethanol among young people in northern Tanzania

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Abstract

Background

The one-month Time Line Follow Back calendar (TLFB) and the Alcohol Use Disorders Identification Test (AUDIT) are used to collect self-reported data on alcohol intake, but have not been evaluated among young people in sub-Saharan Africa, for whom the validity of self-reports is unclear. We validated these instruments against the biomarker Phophatidylethanol (PEth) among young people in northern Tanzania.

Methods

AUDIT and TLFB were applied in a cross-sectional study of 202 young people (18-24 years), who reported using alcohol during the past year (103 male casual labourers; 99

college students). We assayed whole blood for PEth 16:0/18:1, using liquid chromatography-tandem mass spectrometry.

Results

For both self-report methods, alcohol consumption was high, particularly among men (e.g. a median of 54 drinks per month in labourers), and about half of male students (48%) reported hazardous or harmful levels of drinking (AUDIT ≥8). Almost half (49%) of participants were PEth-positive (median concentration 0.03 µmol/L). There were significant positive correlations between reported total alcohol intake and PEth concentration in males (Spearman's correlation r_s=0.65 in college students and r_s=0.57 in casual labourers; p<0.001). Self-reported use in the past month was a sensitive marker of having a positive PEth result (overall, sensitivity 89%, 95%CI 81-94%), and was similar in all groups. The sensitivity of the AUDIT cut-off for hazardous drinking to detect heavy drinking (PEth >30 µmol/L) ranged between 94-100% and the specificity between 67-95%. The optimal AUDIT cut-off for the detection of heavy drinking was ≥13 (sensitivity 96%, specificity 75%).

Conclusion

TLFB and AUDIT are sensitive measures to detect heavy alcohol use among young people in northern Tanzania, compared with PEth They can be used to identify young people who may benefit from alcohol focused interventions.

Key words {AUDIT, TLFB, PEth, young people Tanzania}

(Number of words in the abstract 246)

Introduction

Excessive alcohol use is a major public health problem, and is associated with an estimated 5% of global mortality and 6% of disability adjusted life year's (DALYs) lost globally (World Health Organisation, 2014). It often begins at a young age (Bellis et al., 2009, Swahn et al., Swahn et al., Gore et al.). According to WHO, 46% of the world's adolescents aged 15-19 years reported having ever used alcohol, and 34% had used it in the last year (World Health Organisation, 2014). In Africa, these estimates were 41% and 29% respectively (World Health Organisation, 2014). The estimated prevalence of heavy episodic drinking (defined as intake of at least 6 standard alcoholic drinks on one occasion)(World Health Organisation, 2014) is higher in adolescents than in adults in general populations (adolescents: 12% globally and 8% in Africa; adults: 8% globally and 6% in Africa (World Health Organisation, 2014)).

A recent systematic review showed that alcohol use is also common among young people in eastern Africa, but that few studies used recommended alcohol screening instruments (Francis et al., 2014). Studies to estimate the prevalence of alcohol use and assess the impact of interventions to address hazardous alcohol use in Africa require validated screening tools, based on self-reports. The Alcohol Use Disorders Identification Test (AUDIT), a self-report alcohol screening tool for excessive drinking developed by WHO, has been used in both high and low income countries and recommended for use in primary care settings among adults (O'Connell et al., 2004, Saunders et al., 1993, Chishinga et al., 2011). The Time Line Follow Back (TLFB) calendar method that also relies on self-reported information (in terms of quantity and frequency) has been mainly applied in high-income settings (Sobell and Sobell, 1978, Maisto et al., 1979, Sobell et al., 1986).

Expectations from peers and family members influence both the drinking behaviour of adolescents and young adults, and what they report about it; and these are likely to differ from those of adults (Steinberg and Monahan, 2007, Gardner and Steinberg, 2005). Because AUDIT and TLFB have been shown to be useful tools for alcohol screening in young people in some settings (Sobell et al., 1986, Aertgeerts et al., 2000, Fleming et al., 1991), they are potentially useful to inform alcohol interventions among young people in Africa as well; however, they have not yet been validated among such populations. The objective validation of self-reported alcohol consumption tests requires the use of alcohol biomarkers. A range of blood-based biomarkers exists including phosphatidylethanol (PEth), carbohydrate-deficient transferrin (CDT), and gamma-glutamyl transferase (GGT) (Golka et al., 2004, Golka and Wiese, 2004, Conigrave et al., 2002). PEth is a direct ethanol metabolite in blood that has a comparatively long half-life, and therefore is able to discriminate between levels of alcohol use during the past one month. It has been used among adult populations globally, including in Sub Saharan Africa, to examine self-reported hazardous and harmful alcohol use (Viel et al., 2012, Varga et al., 1998, Isaksson et al., 2011, Hahn et al., 2012b, Hahn et al., 2012a, Bajunirwe et al., 2014).

In this study, we validated self-reported alcohol use recorded by the TLFB and AUDIT against PEth among college students and young casual labourers in northern Tanzania. To our knowledge, this is the first study using an alcohol biomarker (PEth) to validate self-reported alcohol use among young people in Africa.

Material and methods

Study populations and procedures

In March and April 2014, we conducted a cross-sectional study among two groups of young people (college students and casual labourers) in Mwanza city, northern Tanzania. We aimed to enrol participants from these two groups as they are known to include both modest and hazardous/harmful users of alcohol based on recently completed survey in this area. College students comprised students enrolled in higher learning institutions for diploma or undergraduate training, and young casual labourers were recruited from garages (car workshops). Casual workers from this sector are typical for male casual workers with unstable employment in this geographical setting, but can be more easily identified than for example casual workers from temporary building sites.. Participants were eligible if they were aged 18-24 years, reported having consumed alcohol in the last year and provided written informed consent. Impartial witnesses documented the consent for Illiterate study participants. None of the participants was under the influence of alcohol at the time of the interview. Ethical approval was received from the Lake Zone Institutional Review Board at the National Institute for Medical Research (NIMR), Mwanza (MR 53/100/155) and the Ethics Committee of the London School of Hygiene and Tropical Medicine (LSHTM ethics ref 7074). Permission was also obtained from heads of colleges and managers of garages.

At two randomly selected colleges, we randomly selected one class in each college and enrolled all volunteering eligible students. We consecutively visited garages in Mwanza city starting with large garages and enrolled all volunteering eligible casual workers until we attained the desired sample size. The study was performed by two lay research

assistants who administered the AUDIT questionnaire (Saunders et al., 1993) and TLFB calendar (Sobell et al., 1988), and two medical officers who drew blood samples.

We chose a sample size of 200 young people in total based on the assumption that the true prevalence of alcohol use in the last one month among young people in East Africa is about 28% (Francis et al., 2014), and the intention to determine sensitivities and specificities of self-reported alcohol use against PEth with reasonable precision. With a sample of 200 participants, we expected about 46 true positives and 154 true negatives. For a sensitivity of 80% we would expect a 95% confidence interval (CI) ranging from 70.2% to 88.0% ; and for a specificity of 95% a 95%CI interval from 88.5% - 98.7%.

Measurement of self-reported alcohol use

Self-reported alcohol use was documented using AUDIT and TLFB. We applied the TLFB method for the past one month in combination with an alcohol pictorial display, a list of commonly available types of beverages with their standard drinks equivalents and a brief questionnaire, jointly used to determine the type and actual amount of alcohol consumed as accurately as possible (*supplementary files S1&S2)*. In addition, we also asked participants whether they had consumed alcohol in the past 2 and 6 months respectively. We documented the amount of alcohol intake as standard drinks (1 standard drink being equivalent to 10 g of pure alcohol)(World Health Organisation, 2000). We defined an intake of an average of ≥6 drinks per day as 'heavy alcohol intake'.

Blood sample collection, processing and laboratory assay for phosphatidylethanol (PEth)

Each study participant was asked to provide 5 mL of venous whole blood collected into EDTA vacutainer tubes. Before blood collection, the veni-pucture site was swabbed twice with clean water and allowed it to dry. Field workers were instructed not to use alcohol

for sterilisation. The blood samples were immediately stored in a cool box in the field, and transferred to the NIMR laboratory within 3 hours where they were kept at −80°C.

Samples were shipped in dry ice to the Karolinska Institute and Karolinska University Laboratory (Stockholm, Sweden) for assay of PEth 16:0/18:1, the main PEth homologue in human blood (Helander and Zheng, 2009), using liquid chromatography-tandem mass spectrometry (LC–MS/MS). In the laboratory, samples were stored at −80°C until taken for LC–MS/MS analysis, using selected ion monitoring (SIM) in negative mode of the deprotonated molecules (Zheng et al., 2011). The detection limit for whole blood PEth 16:0/18:1 is 0.01 µmol/L. The routinely applied cut-off used to indicate any intake of alcohol for the last one month is ≥0.05 µmol/L, and ≥0.30 µmol/L to indicate heavy alcohol intake (Helander and Hansson, 2013). However, in order to detect any alcohol intake in our study population, we used as cut-off the lowest limit of detection (PEth ≥0.01 µmol/L).

Data management and analysis

Data management

Data were double-entered onto computers at the data management section of the Mwanza Intervention Trials Unit (MITU) at NIMR Mwanza, using the Open Clinica version 3 software. PEth concentration data were merged with the questionnaire data.

Main outcomes

The primary outcomes of interest were i) the correlation between the reported amount of alcohol use recorded by TLFB calendar and the whole blood PEth concentration, ii) sensitivity and specificity of any reported use compared to positive PEth (≥0.01 µmol/L), and iii) sensitivity and specificity of reported heavy alcohol intake (average of ≥6 drinks per drinking event) compared to positive PEth cut-off ≥0.30 µmol/L). Secondary

outcomes were i) sensitivity and specificity of AUDIT compared with positive PEth (≥0.01 µmol/L), and ii) sensitivity and specificity of AUDIT compared with the PEth cut-off for heavy drinking (>0.30 µmol/L).

Statistical procedures

All analyses were conducted using Stata version 13.1. The overall AUDIT score for each participant was calculated and AUDIT scores ≥8 were categorised as hazardous/harmful alcohol use or possible alcohol dependence (Babor, 2001). The TLFB was used to estimate the total reported amount of alcohol consumed, the mean alcohol intake (standard drinks) for each drinking event, and the prevalence of heavy alcohol intake (average of ≥6 drinks per drinking event)(World Health Organisation, 2014) and number of drinking events with heavy intake (≥6 drinks), all reported for the last month.

We estimated the correlation between these different measures of quantity of alcohol consumption with the alcohol biomarker (PEth) concentrations using the Spearman rank correlation coefficient. We compared the distribution of quantity of alcohol consumption by self-report and PEth concentration using the Wilcoxon rank sum test. We computed sensitivities, specificities, positive predictive values (PPV), negative predictive values (NPV) and areas under receiver operating characteristics (AUROC), comparing reported alcohol use by TLFB and AUDIT with PEth.

Results

Characteristics of the population

The study population comprised 202 young people: 103 male casual labourers, 58 male college students and 41 female college students. There were no female casual labourers employed in these garages. The majority (166; 82%) were aged above 20 years. By definition, all participants had consumed alcohol during the last 1 year, but almost all participants (197; 98%) also reported consuming alcohol in the last 6 months and 137 (68%) reported this for the last 1 month. Age at alcohol initiation was below 18 years for most participants (58%). Male casual labourers were more likely to report more total drinks in a month by the TLFB (54 vs 25, $p<0.001$), and to score $\geq$8 points in the AUDIT (66% vs 48%, $p=0.025$) than male college students. Males reported more events with heavy episodic intake than females (Table 1).

Correlation of PEth with reported quantities of alcohol intake

Overall, about half of the participants tested positive on whole blood PEth (98; 48.5%), with a median concentration of 0.03 µmol/L. Specifically, 21(51.2%) female college students, 32 (55.2%) male college students and 45(43.7%) male casual labourers tested positive on whole blood PEth. There was a strong positive correlation between the reported quantities of alcohol intake and the PEth concentration among male casual labourers (Spearman correlation coefficient, $r_s=0.57$; $p<0.001$; Figure 1), and male college students (Spearman correlation coefficient, $r_s=0.65$; $p<0.001$; Figure 2), and moderate correlation among female college students (Spearman correlation coefficient, $r_s=0.45$; $p<0.001$; Figure 3). The correlations followed similar patterns for other parameters of alcohol intake such as number of days drinking, number of drinks at each drinking events, and number of events with heavy episodic intake (Table 2). In addition, there was strong

evidence of an association between median PEth concentration and reported alcohol use (Wilcoxon-rank sum test, p<0.001) in all three study populations.

Performance of self-report against any detectable PEth

Self-reported alcohol use in the past month was a sensitive marker of having a positive PEth result (sensitivity 89%, 95%CI 81-94%), and was similar in the three population groups. In contrast, self-reported alcohol use in the past month had low specificity against PEth, ranging from 48% (95%CI 35-62%) among male casual labourers to 62% (95%CI 41-85%) among female college students (Table 3 and 4).

Performance of self-reported heavy alcohol intake against high levels of PEth

The sensitivity of self-reported heavy alcohol use (average of ≥6 standard drinks per drinking event) when compared with the PEth cut-off for heavy use (≥0.30 µmol/L) was high, ranging from 92 to 100% across groups. The specificity ranged from 64 to 85%. Sensitivity was highest among male college students (100%, 95%CI 59-100%) and specificity was highest among female college students (85%, 95%CI 70-94%) (Tables 3 and4).

Using the standard AUDIT cut-off of ≥8 points, sensitivity against detectable PEth was highest in male casual labourers (87%; 95%CI 73-95%) and lowest in female college students (48%; 95%CI 26-70%). Specificity ranged between 50-95%, was highest in in female college students (95%; 95%CI 75-100%) and lowest among male casual labourers (50%; 95%CI 37-63%) (Table 4). The sensitivity of the standard AUDIT cut-off (≥8) for hazardous drinking in order to detect heavy drinking (PEth >30 µmol/L) ranged between 94-100% and the specificity between 67-95%. The optimal AUDIT cut-off for the detection of heavy drinking was $\underline{\geq}$13 (sensitivity 96%, specificity 75%). (Table 4).

Discussion

To our knowledge, this is the first study to compare the TLFB calendar and AUDIT tools against the alcohol biomarker PEth among young people in sub Saharan Africa. The results suggest that both the one-month-TLFB calendar and AUDIT are sensitive measures to detect heavy alcohol use, but have fairly low sensitivity to detect moderate use (an average of <6 drinks) of alcohol, especially among young women.

Our findings show that the TLFB calendar is a valid tool for reporting alcohol intake among young people, as has also been reported from high income countries for various groups of young people including college students (Sobell et al., 1996, Sobell et al., 1988, Sobell et al., 1986). In our study we used the TLFB calendar together with an additional tool to describe each drinking event and determine more precisely the kind and amount of alcohol consumed at each drinking event (*see supplementary files S1&S2*). This strategy facilitated the documentation of the number of standard drinks consumed, an information that is often not readily available for some alcoholic products such as sachets.

The level of correct self-reporting of high alcohol use among young people in our study was similar to reports from young drug users in the US (Jain et al., 2014). However it stood in contrast to studies conducted in Uganda in adults receiving HIV care and treatment among whom under-reporting was high when compared with PEth (Bajunirwe et al., 2014, Hahn et al., 2012a). The underreporting in the Ugandan study might be attributed to the population characteristics and desirability bias. Our study was carried out in a casual setting with no anticipated favourable or unfavourable consequences, whilst in the Ugandan study patients may have feared that reported alcohol consumption would negatively affect their HIV treatment (Jain et al., 2014, Hahn et al., 2012a,

Bajunirwe et al., 2014). It is worth noting that in another study conducted among HIV patients in Uganda, the prevalence of self-reported alcohol use increased when patients were made aware of a potential assessment with alcohol biomarkers (Hahn et al., 2012b). This suggests that the routine use of alcohol biomarkers even in subsets of a study population, if feasible and affordable, may improve self-reports.

AUDIT showed a very high sensitivity for heavy drinking against PEth in all three study groups, and reasonable specificity. In contrast, AUDIT performed less well when compared against any detectable concentrations of PEth. This suggests that AUDIT may be a valid tool for detecting heavy drinking in young people in sub-Saharan Africa, when using either the WHO recommended AUDIT cut-offs for risky drinking or the optimised cut-off level of 13 that we found in our study (Babor, 2001).

Our findings need to be interpreted in light of the following potential limitations. Whilst PEth is specific in detecting the intake of ethanol, the test is mainly an indicator of prolonged excessive alcohol use and therefore moderate occasional use, or intake that occurred several weeks ago, could result in undetectable PEth levels (the half-life for PEth in blood is about 4-5 days), and this may lead to an underestimation of light to moderate drinking. PEth also shows high inter-individual variation in its metabolism rates (Viel et al., 2012). Lastly, in our study young people came from two selected groups and were recruited in a casual environment, and therefore our findings may not necessarily be representative for other populations of young people, for example those being screened in the context of legal issues or in anticipation of a medical treatment. The one-month-TLFB tool allows assessment of current alcohol consumption, whilst AUDIT assesses consumption, but also suspected dependence and other effects of harmful use.

Generally, AUDIT is easier to administer and can be completed faster than the one-month-TLFB tool, but not provide accurate estimates of actual consumption.

In conclusion, our findings indicate that the one-month-TLFB calendar and AUDIT are valid tools particularly to detect heavy alcohol use among young people in northern Tanzania, and possibly elsewhere in East Africa.

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Author's contribution

JF, HG and HW developed the study design, with contributions from JC, SK and AH. JF, HG, and SK oversaw study implementation and data collection. JF and HW performed data analysis, with contributions from HG. All authors took part in the interpretation of the data. JF, HW and HG drafted the article, and all authors provided critical revisions of the article for important intellectual content. JF is the guarantor of the paper.

Conflict of interest

None

Supplementary Information

Supplementary file S1-Additional information to determine total alcohol intake in a drinking event (*Appendix 4*)

Supplementary file S2-pictures displays of beers *(Appendix 3)*

Figure legends

Figure 1: Scatter plot of the total reported number of drinks by 30-day TLFB and log (PEth) concentration in µmol/L for female college students

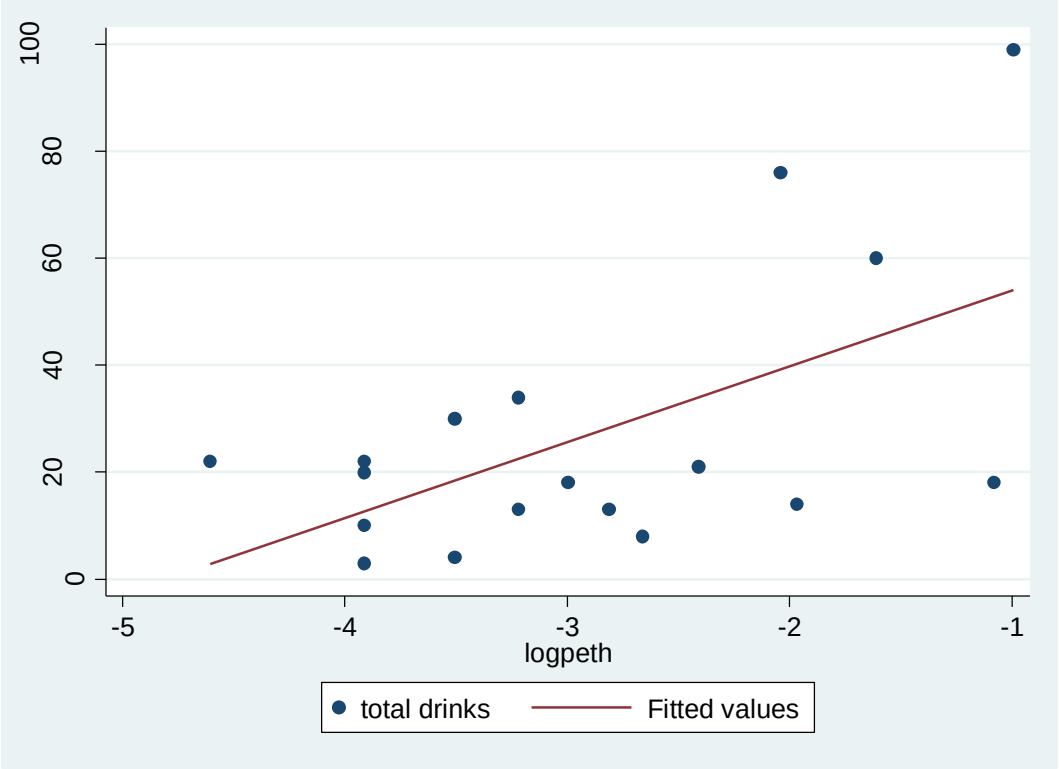


Figure 2: Scatter plot of the total reported number of drinks by 30-day TLFB and log (PEth) concentration in µmol/L for male college students

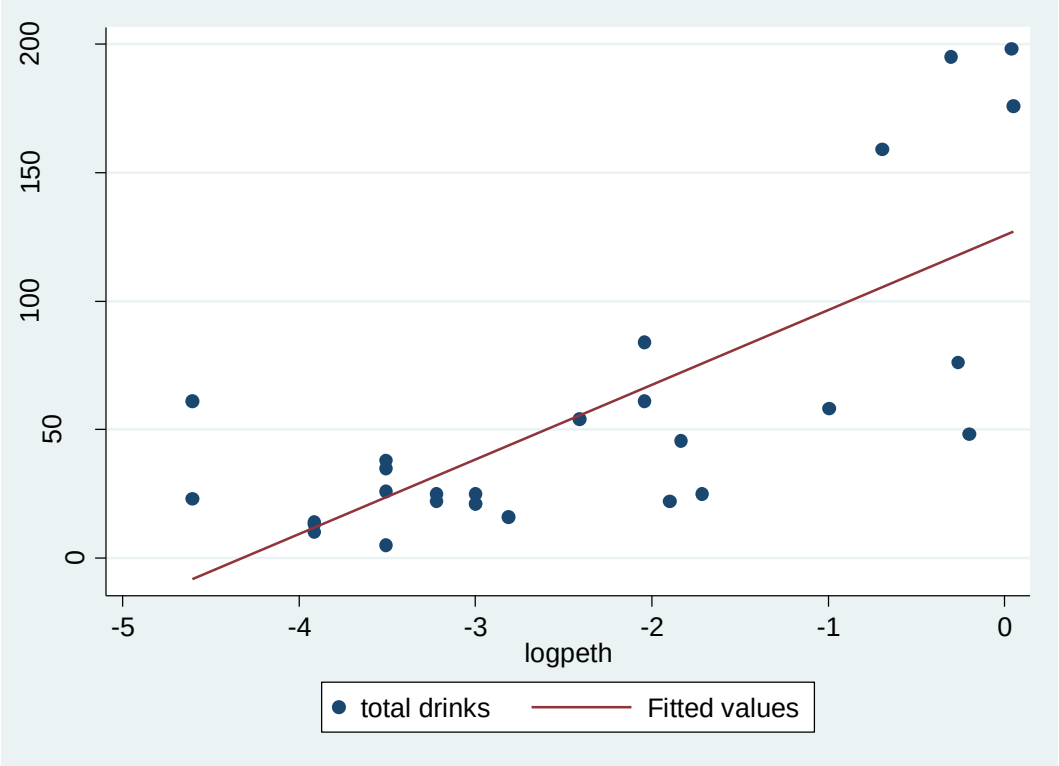


Figure 3: Scatter plot of the total reported number of drinks by 30-day TLFB and log (PEth) concentration in µmol/L for male casual labourers

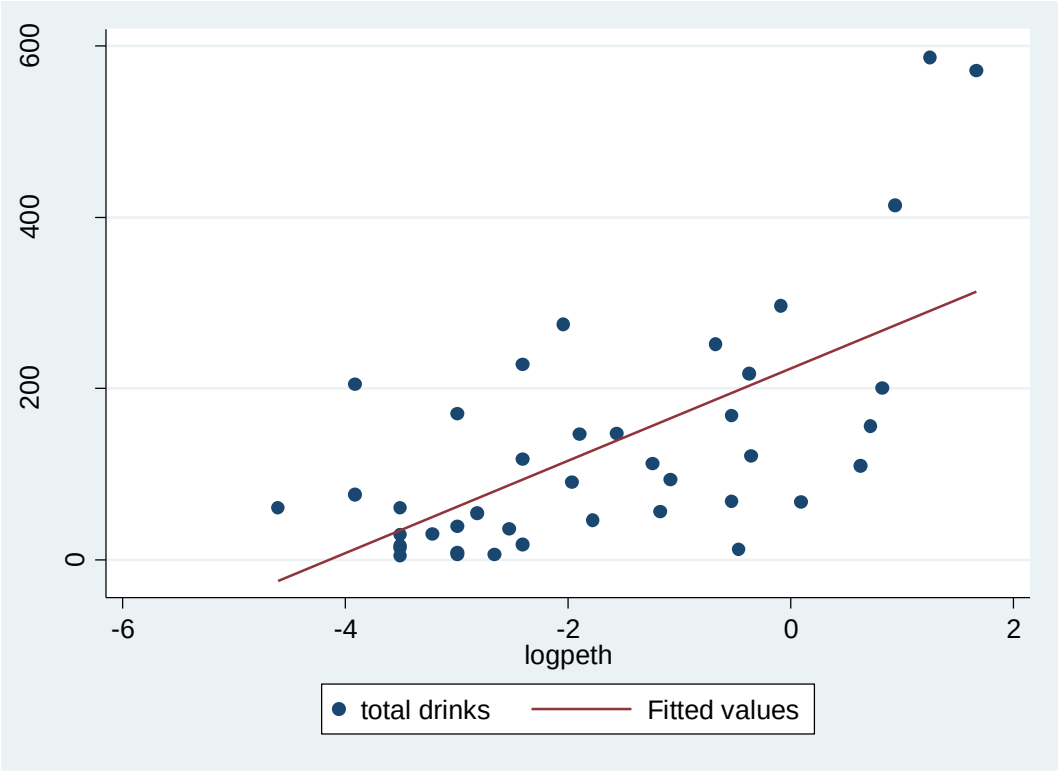
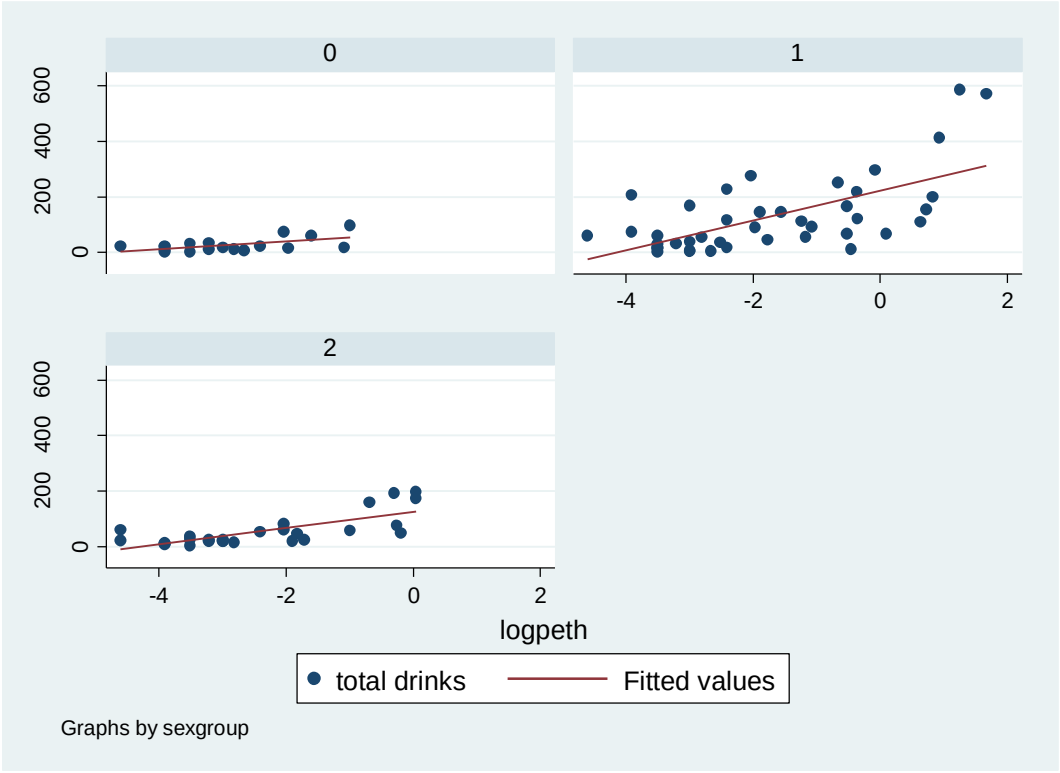


Figure 4: Scatter plot of the total reported number of drinks by 30-day TLFB and log (PEth) concentration in µmol/L for the three study populations(0 " Female college students" 1 " Male casual labourers" and 3 " Male college students)



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Tables of results

Table 1. General characteristics among young people included in the study in northern Tanzania, 2014.

Characteristic	categories	Overall	Female college students	Male college students	Male casual labourers
sample size	**N**	**202**	**41**	**58**	**103**
Age	18-20 years	36(17.8)	4(9.8)	2(3.5)	30 (29.1)
	21-24 years	166 (82.2)	37 (90.2)	56 (96.6)	73 (70.9)
Religion	Moslem	36 (17.8)	8 (19.5)	5 (8.6)	23 (22.3)
	Catholic	102 (50.5)	20 (48.8)	32 (55.2)	50 (48.5)
	Other Christians	64 (31.7)	13 (31.7)	21 (36.2)	30 (29.1)
Education	Primary and less	62 (30.7)	0 (0.0)	0 (0.0)	62 (60.2)
	Secondary and above	140 (69.3)	41 (100.0)	58 (100.0)	41 (39.8)
Marital status	Single	64 (31.8)	9 (22.0)	19 (33.3)	36 (35.0)
	In relationship	137 (68.2)	32 (78.1)	38 (66.7)	67 (65.0)
Age at alcohol initiation	less than 18 years	116 (58.0)	22 (53.7)	34 (59.7)	60 (58.8)
	18-24 years	84 (42.0)	19 (46.3)	23 (40.4)	42 (41.2)
Alcohol use in the last 6 months	Yes	197 (97.5)	38 (92.7)	56 (96.6)	103 (100.0)
Alcohol use in the last 2 months	Yes	158 (78.2)	30 (73.2)	44 (75.9)	84 (81.5)
Alcohol use in the last 30 days	Yes	137 (67.8)	25 (61.0)	41(70.7)	71 (68.9)
Total alcohol intake in a month as reported by TLFB[1](standard drinks)	Median (IQR)	25 (13, 76)	16 (9, 22)	25(13,58)	54 (16, 146)
Average drinking days in a week as reported by the TLFB	None	65 (32.2)	16 (39.1)	17(29.3)	32(31.1)
	1-2 days	107 (53.0)	24 (58.5)	34 (58.6)	49 (47.6)
	Above 2 days	30 (14.9)	1 (2.4)	7 (12.1)	22 (21.4)
Average drinking days in a month as reported by the TLFB	None	65 (32.2)	16 (39.1)	17 (29.3)	32 (31.1)
	1-10 days	114 (56.4)	24 (58.5)	38 (65.5)	52 (50.5)
	Above 10 days	23 (11.4)	1 (2.4)	3 (5.2)	19 (18.4)
At least 1 heavy episodic intake (≥ 6 standard dinks) as reported by TLFB	Yes	115 (56.9)	18 (43.9)	34 (58.6)	63 (61.2)

Heavy episodic alcohol intake (average of ≥6 standard drinks) as reported by TLFB	Yes	77 (38.1)	8 (19.5)	23 (39.7)	46 (44.7)
AUDIT[2] (10 items) score	Median(IQR)	8.5 (5.0, 14.0)	5.0 (3.0-8.0)	7.0 (5.0, 13.0)	10.0 (6.0, 16.0)
AUDIT	<8 (Low risk drinking)	95 (47.0)	30 (73.2)	30 (51.7)	35 (34.0)
	≥ 8 (Risk drinking)	107 (53.0)	11 (26.8)	28(48.3)	68 (66.0)
Phosphatidylethanol (PEth) concentration(µmol/L[3]	Median (IQR)	0.03 (0.00, 0.14)	0.03 (0.00, 0.07)	0.03(0.00, 0.13)	0.03 (0.00, 0.21)
Positive PEth (≥ 0.01 µmol/L)	Yes	98 (48.5)	21 (51.2)	32 (55.2)	45 (43.7)
PEth cut-off for heavy alcohol intake (>0.30 µmol/L)	Yes	25 (12.4)	2 (4.9)	7 (12.1)	16 (15.5)

[1]TLFB-Time Line Follow Back Calendar, [2]AUDIT-Alcohol Use Disorder Identification Test, [3]Only among those reporting any alcohol use in the last one month by TLFB

Table 2. Correlations of alcohol consumption measured by the one-month TLFB questionnaire with PEth concentration (µmol/L) among young people in northern Tanzania.

Measure of alcohol consumption	Median (Interquartile range)	Spearman correlation with PEth value	p value
Overall (n=137)			
PEth (µmol/L)	0.03 (0.00, 0.14)		
Total alcohol intake as reported by TLFB (standard drinks)	25 (13.0, 76.0)	0.55	<0.001
Drinking days in month (days)	5 (3, 8)	0.48	<0.001
Drinking days in a week (days)	1 (1, 2)	0.48	<0.001
Total drinks in occasion (standard drinks)	6.5 (4.0, 10.7)	0.56	<0.001
Episodes of heavy episodic use (≥6 drinks)	3 (1, 7)	0.51	<0.001
Female college students (n=25)			
PEth (µmol/L)	0.03 (0.00, 0.07)		
Total alcohol intake as reported by TLFB (standard drinks)	16 (9.0, 22.0)	0.45	0.02
Drinking days in month (days)	3(2, 6)	0.34	0.09
Drinking days in a week (days)	1 (1, 2)	0.35	0.09
Total drinks in occasion (standard drinks)	4.5 (3.3, 6.0)	0.49	0.01
Episodes of heavy episodic use (≥6 drinks)	1 (0, 3)	0.48	0.02
Male college students (n=41)			
PEth (µmol/L)	0.03 (0.00, 0.13)		
Total alcohol intake as reported by TLFB (standard drinks)	25 (13.0, 58.0)	0.65	<0.001
Drinking days in month (days)	4 (3, 6)	0.54	<0.001
Drinking days in a week (days)	2 (1, 3)	0.54	<0.001
Total drinks in occasion (standard drinks)	6.3 (4.0, 9.0)	0.68	<0.001
Episodes of heavy episodic use (≥6 drinks)	3 (1, 5)	0.64	<0.001
Male casual labourers (n=71)			
PEth (µmol/L)	0.03 (0.00, 0.21)		
Total alcohol intake as reported by TLFB (standard drinks)	54 (16.0, 146.0)	0.57	<0.001
Drinking days in month (days)	6 (3, 12)	0.53	<0.001
Drinking days in a week (days)	1 (1, 2)	0.53	<0.001
Total drinks in occasion (standard drinks)	8.5 (4.0, 12.0)	0.58	<0.001
Episodes of heavy episodic use (≥6 drinks)	4 (2, 10)	0.53	<0.001

Table 3. The distribution of self-reported alcohol use by the one-month TLFB and PEth results among young people in northern Tanzania.

	Reported alcohol use		PEth status	
			Positive (%)	Negative (%)
PEth (≥ 0.01 µmol/L)				
Overall (n=202)	Any drink in the last 30 days	Yes	87 (88.8)	50 (48.1)
		No	11 (11.2)	54 (51.9)
Female college students (n=41)	Any drink in the last 30 days	Yes	18 (85.7)	7 (35.0)
		No	3 (14.3)	13 (65.0)
Male college students (n=58)	Any drink in the last 30 days	Yes	28 (87.5)	13 (50.0)
		No	4 (12.5)	13 (50.0)
Male casual labourers (n=103)	Any drink in the last 30 days	Yes	41 (91.1)	30 (51.7)
		No	8 (8.9)	28 (48.3)
PEth (>0.30 µmol/L)			**Yes**	**No**
Overall (n=202)	Heavy alcohol intake[1] in the last 30 days	Yes	24 (96.0)	53 (29.9)
		No	1 (4.0)	124 (70.1)
Female college students (n=41)	Heavy alcohol intake in the last 30 days	Yes	2 (100.0)	6 (15.4)
		No	0 (0.0)	33 (84.1)
Male college students (n=58)	Heavy alcohol intake in the last 30 days	Yes	7 (100.0)	16 (31.4)
		No	0 (0.0)	35 (68.6)
Male casual labourers (n=103)	Heavy alcohol intake in the last 30 days	Yes	15 (93.8)	31 (35.6)
		No	1 (6.2)	56 (64.4)

[1]Heavy alcohol intake (average of ≥6 drinks per event)

Table 4. Characteristics of tests (any reported use, heavy alcohol intake, and the AUDIT) compared with reference (whole blood PEth) among young people in in northern Tanzania.

Characteristics	Categories	Reported any alcohol use compared with any detectable PEth	Heavy alcohol intake[1] compared with PEth (above 30 µmol/L)	AUDIT-full [2] compared with any detectable PEth	AUDIT-full compared with PEth (above 30 µmol/L)
		X[95% CI]	X[95% CI]	X[95% CI]	X[95% CI]
Area under receiver operating characteristics (AUROC)	Overall (n=202)	0.70[0.63-0.77]	0.83[0.77-0.88]	0.71[0.64-0.77]	0.89[0.84-0.93]
	Male college students (n=58)	0.69[0.55-0.80]	0.79[0.69-0.86]	0.66[0.54-0.79]	0.93[0.83-0.98]
	Male casual labourers (n=103)	0.70(0.60-0.79)	0.79[0.69-0.86]	0.80[0.71-0.87]	0.84[0.76-0.91]
	Female college students (n=41)	0.75[0.60-0.88]	0.92[0.80-0.98]	0.72[0.54-0.84]	0.96[0.83-0.99]
Sensitivity	Overall (n=202)	0.89[0.81-0.94]	0.96[0.80-1.00]	0.69[0.59-0.78]	0.96[0.80-1.00]
	Male college students (n=58)	0.88[0.71-0.97]	1.00[0.59-1.00]	0.59[0.41-0.76]	1.00[0.59-1.00]
	Male casual labourers (n=103)	0.91[0.79-0.98]	0.94[0.70-1.00]	0.87[0.73-0.95]	0.94[0.70-1.00]
	Female college students (n=41)	0.86[0.64-0.97]	0.92[0.80-0.98]	0.48[0.26-0.70]	1.00[0.16-1.00]
Specificity	Overall (n=202)	0.52[0.42-0.62]	0.70[0.63-0.77]	0.63[0.53-0.72]	0.75[0.68-0.81]
	Male college students (n=58)	0.50[0.30-0.70]	0.69[0.54-0.81]	0.65[0.44-0.83]	0.73[0.58-0.84]
	Male casual labourers (n=103)	0.48[0.35-0.62]	0.64[0.53-0.74]	0.50[0.37-0.63]	0.67[0.56-0.76]
	Female college students (n=41)	0.65[0.41-0.85]	0.85[0.70-0.94]	0.95[0.75-1.00]	0.95[0.83-0.99]
Positive predictive values (PPV)	Overall (n=202)	0.64[0.55-0.72]	0.31[0.21-0.43]	0.64[0.54-0.73]	0.35[0.24-0.47]
	Male college students (n=58)	0.68[0.52-0.82]	0.30[0.13-0.53]	0.68[0.48-0.84]	0.33[0.15-0.57]
	Male casual labourers (n=103)	0.58[0.45-0.69]	0.33[0.20-0.48]	0.57[0.45-0.69]	0.34[0.21-0.50]
	Female college students (n=41)	0.72[0.51-0.88]	0.25[0.03-0.65]	0.91[0.59-1.00]	0.50[0.07-0.93]

Negative predictive values (NPV)	Overall (n=202)	0.83[0.72-0.91]	0.99[0.96-1.00]	0.68[0.58-0.78]	0.99[0.96-1.00]
	Male college students (n=58)	0.77[0.50-0.93]	1.00[0.90-1.00]	0.57[0.37-0.75]	1.00[0.91-1.00]
	Male casual labourers (n=103)	0.88[0.71-0.97]	0.98[0.91-1.00]	0.83[0.66-0.93]	0.98[0.91-1.00]
	Female college students (n=41)	0.81[0.54-0.96]	1.00[0.89-1.00]	0.63[0.44-0.80]	1.00[0.91-1.00]
Optimal cut off point at maximum sensitivity and specificity	Overall (n=202)			9	13
	Male college students (n=58)			9	13
	Male casual labourers (n=103)			9	13
	Female college students (n=41)			8	13
Prevalence PEth positive	Overall (n=202)	0.49[0.41-0.56][3]	0.12[0.08-0.18][4]	0.49[0.41-0.56][3]	0.12[0.08-0.18][4]
	Male college students (n=58)	0.55[0.42-0.68]	0.12[0.05-0.23]	0.55[0.42-0.68]	0.12[0.05-0.23]
	Male casual labourers (n=103)	0.44[0.34-0.54]	0.16[0.09-0.24]	0.44[0.34-0.54]	0.16[0.09-0.24]
	Female college students (n=41)	0.51[0.35-0.67]	0.05[0.0-0.17]	0.51[0.35-0.67]	0.05[0.00-0.17]

[1]Heavy alcohol intake (average of ≥6 drinks per event), [2]Sensitivities, specificities, PPV and NPV the cut off point for AUDIT score was ≥8 [3] Any detectable PEth [4] PEth cut off of heavy use

Chapter 6. Validation of the MINI (DSM IV) tool for the assessment of alcohol dependence among young people in northern Tanzania using the alcohol biomarker Phosphatidylethanol (PEth)

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SECTION A – Student Details

Student	Joel Msafiri Francis
Principal Supervisor	Heiner Grosskurth
Thesis Title	EPIDEMIOLOGY OF ALCOHOL USE AND ALCOHOL USE DISORDERS (AUD) AMONG YOUNG PEOPLE IN NORTHERN TANZANIA

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	International Journal of Envromental Research and Public Health
Please list the paper's authors in the intended authorship order:	Joel M Francis, Anders Helander, Saidi H Kapiga, Helen A Weiss, Heiner Grosskurth
Stage of publication	**Submitted**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I developed the study design with inputs from Helen Weiss, Heiner Grosskurth, Saidi Kapiga and Anders Helander. I oversaw the study implementation and data collection. Anders Helander perfomed Phosphatidylethanol assays at the Karolinska university laboratory. I performed data

	analysis with inputs from Helen Weiss and Heiner Grosskurth. I interpreted the results and drafted the article and then all co-authors provided critical comments on the interpretation of the data and the draft article. I am the guarantor of the paper.

Student Signature: Unsgtir. **Date:** 30.07.15

Supervisor Signature: **Date:** 30.7.2015

Validation of the MINI (DSM IV) tool for the assessment of alcohol dependence among young people in northern Tanzania using the alcohol biomarker Phosphatidylethanol (PEth)

Authors

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Abstract

Background

The Mini International Neuropsychiatric Interview questionnaire (MINI) has not been evaluated in young Africans. The aim of this study was to compare the MINI alcohol dependence section among young people in N-Tanzania with the biomarker Phophatidylethanol (PEth).

Methods

We applied the MINI in a cross-sectional study of 202(103 male casual workers; 99 students) young (18-24 years) drinkers. We assayed whole blood for PEth 16:0/18:1, using liquid chromatography-tandem mass spectrometry.

Results

The MINI alcohol dependence criteria (positive responses to ≥3 questions) was met by 79 (39%) participants, mainly due to two non-specific questions (on tolerance and compulsion to drink). The sensitivity ranged from 0%-69% (in female students and male workers respectively) and specificity from 52%-85% (in male workers and female students, respectively). The highest AUROC statistic (0.68) occurred with a cut-off of ≥4 positive responses (male students). Using a modified MINI with 3 affirmative responses to 5 selected questions increased specificity to 92-97%), however sensitivity remained low.

Conclusion

The sensitivity and specificity of the MINI to detect alcohol dependence in young people in N-Tanzania is not satisfactory. Specificity can be improved using a modified version but sensitivity remains low.

Key words {MINI, DSM IV, AUDIT, PEth, Alcohol dependence, young people Tanzania}

(Number of words 190)

Introduction

Harmful alcohol use in young people is becoming an increasingly significant public health problem in low-income settings including sub Saharan Africa [1]. The problem is also common among young people in East Africa but the diagnosis of harmful use and alcohol dependence among young people remains challenging due to lack of validated diagnostic tools [2].

The Diagnostic and Statistical Manual of mental health disorders, 4th edition (DSM IV) and the International Classification of Diseases, version 10 (ICD-10) are acknowledged tools for the diagnosis and classification of mental health disorders including alcohol use disorders [3,4]. These instruments are utilized both in low- and high-income settings. The Mini International Neuropsychiatric Interview questionnaire (MINI) is based on the DSM IV and ICD-10 and is widely used to identify patients with suspected alcohol abuse and alcohol dependence in clinical and research settings [5](see also Annex 1). DSM IV has recently been replaced by DSM-5. In DSM-5 the formerly distinct diagnoses of substance abuse and dependence have been unified into one diagnosis ('substance use disorder' - SUD) for which the originally separate lists of diagnostic criteria have been merged and slightly modified[6,7]. However, the MINI continues to be used in research on alcohol related disorders [8].

The application of the DSM IV and MINI diagnostic criteria in young people is challenging and has been a subject of debate for many years due to two highly sensitive questions on craving for and compulsion to alcohol use that seem rather non-specific when applied to those who started using alcohol not long ago [9-11] . These questions are *"Did you need to drink a lot more in order to get the same effect you got when you started first*

drinking or did you get much less effect with continued use of the same amount?" (MINI question I2a), and *"During the times when you drank alcohol, did you end up drinking more than you planned when started?"* (MINI question I2c) The questions do not sufficiently take developmental issues and young people's perceptions and intentions into account, and responses may therefore be misleading.

This lack of specificity may also affect the application of the MINI in the context of alcohol use among young people in sub-Saharan Africa (SSA). In our study, we aimed to explore the validity of the MINI version 6.0 in detecting alcohol dependence by applying it to young drinkers recruited from a large city in East Africa. Because there is no objective (i.e. non-self-report based) gold-standard methodology to diagnose dependence, we used an assay to detect Phosphatidylethanol (PEth), a biological marker indicating chronic alcohol use, to validate the MINI. We did this based on the assumption that alcohol dependence among young people will usually be associated with continued or episodic excessive alcohol intake. Phosphatidylethanol (PEth) is an ethanol metabolite found in blood that has a comparatively long half-life, and the assay can be applied to identify excessive alcohol use that occurred over recent weeks, and to discriminate between levels of alcohol use. PEth has been previously used to compare self-reported hazardous and harmful alcohol use in SSA [12-17]. To our knowledge, this is the first study using an alcohol biomarker to validate the MINI for alcohol dependence among young people in Africa.

Experimental section

Study population and procedures

In March and April 2014, we conducted a cross-sectional study among two groups of young people (college students and casual labourers) in Mwanza city, northern Tanzania. Male and female college students were recruited from higher learning institutions, and casual labourers comprised young men working in garages (car workshops). Casual workers from this sector are typical for male casual workers with unstable employment in this geographical setting, but can be more easily identified than for example casual workers from temporary building sites. We recruited young people aged 18-24 years who reported to have consumed alcohol at least once in the last year. Earlier research in this population showed that alcohol use is initiated early, with a median age of 17 years (Francis et al 2015). We enrolled those who provided written informed consent, and impartial witnesses documented the consent forms for Illiterate study participants. None of the study participants was under the influence of alcohol at the time of the interview. Ethical approval was received from the Lake Zone Institutional Review Board at the National Institute for Medical Research (NIMR) Mwanza (MR 53/100/155) and the London School of Hygiene and Tropical Medicine (LSHTM ethics ref 7074).

We randomly selected one class each at two randomly chosen colleges, and enrolled all eligible and consenting students. We consecutively visited garages in Mwanza city

starting with large garages and enrolled all eligible casual workers until we attained the desired sample size. The study was performed by two young trained research assistants who administered the Alcohol Use Disorder Identification Test (AUDIT) [18] and two medical officers who administered the MINI and drew blood samples after having been trained in the application of this tool for one week by a specialist psychiatrist jointly with the principal investigator. Study participants and research assistants were matched by gender for comfortability during the interviews and to minimize bias.

Sample size

We chose a sample of 200 young alcohol users with the aim to achieve good precision for the detection of alcohol dependence by MINI against PEth at a cut off level that is accepted to indicate heavy use (>0.30µmol/L)[19]. Assuming a true prevalence of alcohol use disorders including possible dependence among young people in eastern Africa of 15% [2], a sample of 200 young people would provide reasonable precision for estimates of sensitivity and specificity. For example, for a sensitivity of 80% or 95% we would obtain 95% confidence intervals (CI) of 61.4 - 92.3% and 77.9 - 99.1% respectively. For a specificity of 80% or 95%, the 95% CI would be 73.2 - 85.7% and 90.9 - 98.0% respectively.

Measurement of self-reported alcohol use and alcohol dependence

Self-reported alcohol use was documented using AUDIT and the alcohol dependence related section I2 of the MINI version 6.0 [5]. This section of the MINI contains 7 questions derived from DSM IV that are designed to detect possible alcohol dependence (Annex 1).

Blood sample collection, processing and laboratory assay for phosphatidylethanol (PEth)

Each study participant was asked to provide 5mL of venous blood collected into EDTA vacutainer tubes. Before collection, the veni-pucture site was swabbed twice with clean water and allowed to dry. Field workers were instructed not to use alcohol for

sterilisation of the skin. The blood samples were immediately stored in a cool box in the field, and transferred to the laboratory of the National Institute for Medical Research (NIMR) in Mwanza within 3 hours where they were kept at −80°C. Samples were then sent on dry ice to the Karolinska Institute and Karolinska University Laboratory (Stockholm, Sweden) for assay of PEth 16:0/18:1, the main PEth homologue in human blood [20], using liquid chromatography-tandem mass spectrometry (LC–MS/MS). In the laboratory, samples were stored at −80°C until taken for LC–MS/MS analysis, using selected ion monitoring (SIM) in negative mode of the deprotonated molecules[21]. The detection limit for whole blood PEth 16:0/18:1 is 0.01 µmol/L. The routinely applied cut-off used to indicate any intake of alcohol is ≥0.05 µmol/L, and ≥0.30 µmol/L to indicate heavy alcohol use was used as a cut off to indicate alcohol dependence for this study [19].

Data management and analysis

Data were double-entered into computers at the data management unit of the Mwanza Intervention Trials Unit (MITU) at NIMR, using version 3 of the Open Clinica software (OpenClinica, LLC (2014). PEth concentration data were merged with the questionnaire data, and data were exported to Stata 13 for analysis (StataCorp (2013), College Station, TX).

The MINI criteria indicating dependence are met when 3 or more of the 7 questions in section I2 are answered with "YES" (Annex 1). We determined the sensitivity and specificity of the resulting classification against PEth at a level of ≥0.30 µmol/L. We also generated a modified version of the MINI in which the first and third version (MINI questions I2a and I2c) were excluded due to their lack of specificity, and defined dependence as meeting 3 out of the 5 remaining questions. We also validated both versions of the MINI for other cut-offs in the number of positively answered questions.

For each possible cut-off level, we calculated the area under the receiver-operating characteristic (AUROC).

Primary outcomes were i) the sensitivity and specificity of the original MINI criteria , and ii) the sensitivity and specificity of varied cut-off points of the modified MINI, both calculated against a diagnosis of heavy alcohol use determined by PEth (>0.30 μmol/L) [21].

In addition, for different MINI response rates we computed respondents' total AUDIT scores and corresponding median and interquartile ranges. The standard AUDIT cut-off score of ≥8 was used to categorise 'hazardous/harmful alcohol use or possible alcohol dependence' [22].

Results

Characteristics of the population

We recruited 202 young people that comprised 103 (51%) male casual labourers, 58 (29%) male college students and 41 (20%) female college students. Women were not employed in any of the garages from where casual workers were recruited. The majority 166 (82%) of the participants were aged above 20 years. Approximately half (107; 53%) had an AUDIT score of 8 or more, with male casual labourers reporting this most frequently (66%). The median AUDIT score was highest among male casual labourers (10; IQR: 6-16) and lowest among female college students (5; IQR: 3-8). Nine (9%) of male casual labourers were suspected to be alcohol dependent by AUDIT criteria, and fewer than 4% of college students (Table 1).

Responses to MINI questions and characteristics of respondents

Most participants 177 (88%) responded with "Yes" to MINI question I2a *"Did you need to drink a lot more in order to get the same effect you got when you started first drinking or did you get much less effect with continued use of the same amount?"* (Table 2). The median AUDIT score among these participants was 9 (IQR: 6-15) and was only 5 (IQR: 2-6) among those who responded with "No". MINI question I2c *"During the times when you drank alcohol, did you end up drinking more than you planned when started?*" was answered affirmatively by 121 (63%) participants, among whom the median AUDIT score was 11 (IQR: 7-17) whilst it was 5 (IQR: 3-9) among those responding with 'No'. For the remaining questions, the proportion with a positive response ranged between 7-28% with median AUDIT scores ranging from 12-16 (Table 2). Overall, 79/202 (39%) participants responded affirmatively to 3 or more MINI I2 questions and thus met the criteria for dependence; 15%, 35% and 51% among female students, male students and

male casual workers, respectively, (Table 3). Because of these findings, we regarded questions MINI I2a and I2c as too unspecific to detect alcohol dependence and excluded them from the modified version of MINI.

Sensitivities and specificities of the original and modified versions of MINI compared to PEth.

The sensitivity of the original version of the MINI when compared to the PEth cut-off for heavy drinking (≥0.30 µmol/L) was low, ranging from 0% (among female college students) to 69% (among male casual labourers) (Table 3). The specificity ranged from 52% (male causal labourers) to 85% (female college students). A positive response to ≥5 questions yielded an overall sensitivity of 12% and specificity of 94%. Using the modified version of the MINI (with 3 "YES" responses out of 5 selected DSM IV questions), specificity against PEth (≥0.30 µmol/L) was high in all groups (92-97%), however sensitivity was poor (ranging from 0-14% across groups) – i.e. few of those with positive PEth results scored positive on the modified MINI questionnaire (Table 4). The highest AUROC statistic (0.68) was achieved when applying the original MINI with a cut-off level of 4 or more positive responses, in the group of male college students (Table 3).

Discussion

The MINI when applied with the original criteria (≥3 " Yes" responses to 7 dependence questions) showed low sensitivity and fair specificity among young people in northern Tanzania when using the alcohol biomarker PEth with a cut off for heavy drinking (≥0.30 µmol/L) as a proxy for objectively assessing alcohol dependence. The sensitivity was low because many participants with confirmed heavy chronic alcohol use did not respond positively to the relevant MINI screening questions. The lack of specificity resulted mainly from the two questions related to alcohol tolerance and compulsion to drink that were answered positively by most young people in our study. This problem has been observed by others and the two questions have been subject of debate for many years [9,10]. Our modified version of the MINI (excluding questions I2a and I2c) and using a cut-off point of ≥3 "Yes" response) was highly specific but still had low sensitivity. The same applied if the original 7-question MINI tool was used at a higher cut-off of 5 or more positive responses.

Given that the MINI is frequently applied as a diagnostic tool, and that a diagnosis of alcohol dependence may be highly stigmatising particularly among young people high specificity is a desired test feature. However, the low sensitivity is a matter of concern as a PEth level of ≥0.30 µmol/L clearly indicates heavy alcohol use.

In consequence, in order to address harmful drinking among young people in East Africa and elsewhere, the AUDIT questionnaire remains a sensitive tool to identify problematic levels of alcohol use, and AUDIT scores of 8 or more should trigger efforts towards targeted health education. Attempting to diagnose alcohol dependence using the original version of the MINI can however not be recommended due to its lack of specificity; and

more stringent cut-offs or a modified version of the MINI are required. However the sensitivity of any of these options is low, and health workers need to be aware that the application might be associated with a false negative diagnosis.

The new version of diagnostic statistical manual the DSM-5 [6] still includes the two questions that pose specificity problems in the diagnosis of dependence among young people in general, [23] and as shown this applies also to our part of east Africa. The concerns we described for the MINI / DSM IV would remain when the DSM-5 would be applied to young people.

Our study has some limitations. Firstly, the PEth assay is known to show substantial inter-individual variation in its metabolism and this may imply a potential misclassification if PEth metabolised very quickly or very slowly, leading to an under- or over-diagnosis of problem drinking[12]. Secondly, not all cases of chronic heavy alcohol use may reflect alcohol dependence; and vice versa, there may be genuinely alcohol dependent individuals who have not used alcohol for some weeks and will therefore be PEth negative. Thirdly, responses to questions on reported alcohol use may be subject to social desirability bias. Drinking behaviour may have been underreported, but we can also not exclude that the amount of alcohol taken may have been exaggerated by some young people, e.g. out of a desire to impress interviewers. To minimize these types of bias, we ensured that interviewers and interviewees were of the same gender, that study staff were comparatively young themselves, and were trained to provide a friendly and conducive atmosphere during the interview.

Given the high but still increasing problem of harmful alcohol use among young people in low-income settings [1] the already pressing need for interventions at population and

individual level will become even more urgent in future. An accurate tool for the diagnosis of alcohol dependence is needed both for epidemiological and clinical purposes, and it will be crucial in facilitating appropriate care for alcohol dependent young people. Our study shows that the tools currently available for the diagnosis of alcohol dependence among young people in Africa are inadequate.

Supplementary material

S1: Annex 1-Alcohol section dependence of the MINI tool *(Appendix 4)*

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Author's contribution

JF, HG, SK and HW developed the study design, with contributions from AH. JF, HG, and SK oversaw study implementation and data collection. JF and HW performed data analysis, with contributions from HG and AH. All authors took part in the interpretation of the data. JF, HW and HG drafted the article, and all authors provided critical revisions of the article for important intellectual content. JF is the guarantor of the paper.

Conflict of interest

No conflict of interest

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Tables of results

Table 1- General characteristics of the study population					
Characteristic	categories	Overall	Female college students	Male college students	Casual labourers
Sample	N	**202**	**41**	**58**	**103**
Age	18-20 years	36(17.8)	4(9.8)	2(3.5)	30(29.1)
	21-24 years	166(82.2)	37(90.2)	56(96.6)	73(70.9)
Religion	Moslem	36(17.8)	8(19.5)	5(8.6)	23(22.3)
	Catholic	102(50.5)	20(48.8)	32(55.2)	50(48.5)
	Other Christians	64(31.7)	13(31.7)	21(36.2)	30(29.1)
Education	Primary and less	62(30.7)	0(0.0)	0(0.0)	62(60.2)
	Secondary and above	140(69.3)	41(100.0)	58(100.0)	41(39.8)
Marital status	Single	64(31.8)	9(22.0)	19(33.3)	36(35.0)
	In relationship	137(68.2)	32(78.1)	38(66.7)	67(65.0)
Age at alcohol initiation	less than 18 years	116(58.0)	22(53.7)	34(59.7)	60(58.8)
	18-24 years	84(42.0)	19(46.3)	23(40.4)	42(41.2)
AUDIT(10 items) score	Median(IQR)	8.5(5.0,14.0)	5.0(3.0-8.0)	7.0(5.0, 13.0)	10.0(6.0, 16.0)
AUDIT	<8 (Low risk drinking)	95(47.0)	30(73.2)	30(51.7)	35(34.0)
	≥ 8 (Risk drinking)	107(53.0)	11(26.8)	28(48.3)	68(66.0)
Dependence by AUDIT dependence questions	No	190(94.1)	40(97.6)	56(96.6)	94(91.3)
	Yes	12(5.9)	1(2.4)	2(3.5)	9(8.7)

Table 2: MINI responses compared to AUDIT score and PEth (>0.30µmol/L)					
Variables	Responses	N (%)	Dependent by original DSM IV criteria N (%)	PEth(>0.30µmol/L) N (%)	Median(IQR) AUDIT score
DSM IV- dependence question 1:Did you need to drink a lot more in order to get the same effect you got when you started first drinking or did you get much less effect with continued use of the same amount?	Yes	177(87.6)	79(44.6)	25(14.1)	9[6,15)
	No	25(12.4)	0(0.0)	0(0.0)	5(2,6)
DSM IV-dependence question 2: When you cut down on drinking did your hands shake, did you sweat or feel agitated? Did you drink to avoid these symptoms (for example, "the shakes", sweating or agitation) or to avoid being hungover?	Yes	17(8.4)	17(100.0)	5(29.4)	13(7,19)
	No	185(91.6)	62(33.5)	20(10.8)	8(5,13)
DSM IV-dependence question 3: During the times when you drank alcohol, did you end up drinking more than you planned when started?	Yes	121(59.9)	73(60.3)	22(18.1)	11(7,17)
	No	81(40.1)	6(7.4)	5(3.7)	5(3,9)
DSM IV-dependence question 4: Have you tried to reduce or stop drinking alcohol but failed?	Yes	55(27.2)	47(85.5)	11(20.0)	12(7,19)
	No	147(72.8)	32(21.8)	14(9.5)	7(5,12)
DSM IV-dependence question 5:On the days that you drank, did you spend substantial time in obtaining alcohol, drinking, or in recovering from the effects of alcohol?	Yes	33(16.3)	33(100)	6(18.2)	16(9,19)
	No	169(83.7)	46(27.2)	19(11.2)	7(5,12)
DSM IV-dependence question 6: Did you spend less time working, enjoying hobbies ir being with others because of your drinking?	Yes	36(17.8)	34(94.4)	6(16.7)	13[8,19)
	No	166(82.2)	45(27.1)	19(11.5)	7(5,12)
DSM IV-dependence question 7:If your drinking caused you health or mental problems, did you still keep on drinking?	Yes	13(6.4)	10(76.9)	4(30.8)	12(11,18)
	No	189(93.6)	69(36.5)	21(11.1)	8(5,13)

Table 3- - Sensitivity and Specificity of MINI compared with PEth(>0.30µmol/L)					
Populations	Dependence by DSM IV		PEth(>0.30µmol/L)		Area under receiver operating characteristics (AUROC)
			Positive	Negative	
Overall(n=202)	≥3 dependence questions	Yes	15(60.0)[1]	64(36.2)	0.62(0.52-0.72)
		No	10(40.0)	113(63.8)[2]	
Female college students(n=41)	≥3 dependence questions	Yes	0(0.0)	6(15.4)	0.42(0.37-0.48)
		No	2(100.0)	33(84.6)	
Male college students(n=58)	≥3 dependence questions	Yes	4(57.1)	16(31.4)	0.63(0.42-0.84)
		No	3(42.9)	35(68.6)	
Male casual labourers(n=103)	≥3 dependence questions	Yes	11(68.8)	42(48.3)	0.60(0.47-0.73)
		No	5(31.3)	45(51.7)	
Overall(n=202)	≥4 dependence questions	Yes	10(40.0)	29(16.4)	0.62(0.52-0.72)
		No	15(60.0)	148(83.6)	
Female college students(n=41)	≥4 dependence questions	Yes	0(0.0)	3(7.7)	0.46(0.42-0.50)
		No	2(100.0)	36(92.3)	
Male college students(n=58)	≥4 dependence questions	Yes	3(42.9)	4(7.8)	0.68(0.47-0.88)
		No	4(57.1)	47(92.2)	
Male casual labourers(n=103)	≥4 dependence questions	Yes	7(43.8)	22(25.3)	0.59(0.46-0.73)
		No	9(56.2)	65(74.7)	
Overall(n=202)	≥5 dependence questions	Yes	3(12.0)	9(5.1)	0.54(0.47-0.60)
		No	22(88.0)	168(94.9)	
Female college students(n=41)	≥5 dependence questions	Yes	0(0.0)	1(2.6)	0.49(0.46-0.51)
		No	2(100.0)	38(97.4)	
Male college students(n=58)	≥5 dependence questions	Yes	1(14.3)	1(2.0)	0.56(0.42-0.70)
		No	6(85.7)	50(98.0)	
Male casual labourers(n=103)	≥5 dependence questions	Yes	2(12.5)	7(8.0)	0.52(0.43-0.61)
		No	14(87.5)	80(92.0)	

[1]Sensitivity, [2]Specificity

Table 4- Sensitivity and Specificity of modified MINI compared with PEth(>0.30µmol/L)					
Populations	Dependence by modified DSM IV		PEth(>0.30µmol/L)		Area under receiver operating characteristics (AUROC)
			Positive	Negative	
Overall(n=202)	≥1 dependence questions	Yes	16(64.0)[1]	76(42.9)	0.61(0.50-0.71)
		No	9(36.0)	101(57.1)[2]	
Female college students(n=41)	≥1 dependence questions	Yes	0(0.0)	8(20.5)	0.40(0.33-0.46)
		No	2(100.0)	31(79.5)	
Male college students(n=58)	≥1 dependence questions	Yes	4(57.1)	20(39.2)	0.59(0.38-0.80)
		No	3(42.9)	31(60.8)	
Male casual labourers(n=103)	≥1 dependence questions	Yes	12(75.0)	48(55.2)	0.60(0.48-0.72)
		No	4(25.0)	39(44.8)	
Overall(n=202)	≥2 dependence questions	Yes	10(40.0)	35(19.8)	0.60(0.50-0.70)
		No	15(60.0)	142(80.2)	
Female college students(n=41)	≥2 dependence questions	Yes	0(0.0)	3(7.7)	0.46(0.42-0.50)
		No	2(100.0)	36(92.3)	
Male college students(n=58)	≥2 dependence questions	Yes	3(42.9)	6(11.8)	0.66(0.45-0.86)
		No	4(57.1)	45(88.2)	
Male casual labourers(n=103)	≥2 dependence questions	Yes	7(43.8)	26(29.9)	0.57(0.44-0.70)
		No	9(56.2)	61(70.1)	
Overall(n=202)	≥3 dependence questions	Yes	3(12.0)	9(5.1)	0.54(0.47-0.60)
		No	22(88.0)	168(94.9)	
Female college students(n=41)	≥3 dependence questions	Yes	0(0.0)	1(2.6)	0.49(0.46-0.51)
		No	2(100.0)	38(97.4)	
Male college students(n=58)	≥3 dependence questions	Yes	1(14.3)	1(2.0)	0.56(0.42-0.70)
		No	6(85.7)	50(98.0)	
Male casual labourers(n=103)	≥3 dependence questions	Yes	2(12.5)	7(8.0)	0.52(0.43-0.61)
		No	14(87.5)	80(92.0)	

[1]Sensitivity, [2]Specificity

Chapter 7. Discussion

Excessive alcohol use among young people is a significant public health problem and is associated with 7% of the incident disability-adjusted life-years (DALYs) lost globally among 10-24 year olds [1,2]. My PhD research aimed to collate existing data on alcohol use among young people from East Africa, and to fill important information gaps by conducting epidemiological studies in northern Tanzania and evaluating some commonly used tools to measure alcohol consumption. The results of my research can be summarised and discussed under two main themes; i) implications of the findings with respect to the epidemiology of alcohol use and AUD among young people in Eastern Africa; and ii) implications of the findings for the methodologies available to measure alcohol intake and diagnose AUD in these groups. These two main aspects are addressed in turn below. In addition, this chapter also looks at the implication of the research for interventions that will be needed to protect young people in East Africa against the consequences of excessive alcohol use.

Epidemiology of alcohol use and AUD among young people

The systematic review confirmed that alcohol use disorders are indeed common among various groups of young people in eastern Africa. Groups that are particularly affected by alcohol use and AUD include college and university students, sex workers and men who have sex with men. Our field studies in four groups of young people from Kilimanjaro and Mwanza Regions in Tanzania did not look at the situation of sex workers and of men who have sex with men, but they confirmed that alcohol use was high among college students in these areas of Tanzania, particularly male students, and among casual labourers. Originally, instead of casual workers, we had planned to recruit jobless young people, but these were difficult to identify in a systematic way, and so we worked with casual workers

as a proxy for this disadvantaged sector of the East African society. In these groups, alcohol use was high across all definitions applied (ever use, use in the last year and use in the last month) and the prevalence of alcohol use was higher than the WHO estimates for Africa region [1]. Alcohol use and AUD were both significantly associated with reported risky sexual behaviours (i.e. with a higher number of sexual partners), but also with being male, being in a relationship, having a higher disposable income and with living within a permissible drinking culture as in our study being a resident of Kilimanjaro region was a risk for alcohol use (chapter 4). The findings confirm observations that have been made also by others, particularly with respect to risky sexual behaviours [3-6].

The studies had a number of limitations: firstly, the cross-sectional design of the survey in Mwanza and Kilimanjaro Regions precluded causal inference for factors associated with alcohol use. For example, risky sexual behaviour may be both a consequence of excessive alcohol intake, or occur commonly in connection with alcohol use as an expression of tendency for risk seeking as it has been described among young people [7]. It was also difficult to identify female casual workers, and so our research is limited with respect to the generalizability to women except for student groups. Our results may have been affected by under- or over-reporting, e.g. due to social desirability bias or recall bias with regards to the reported amounts of alcohol use, an issue addressed in the chapter validating self-reported alcohol use against the biomarker PEth (chapter 5).

Alcohol screening tools

One key finding from the systematic review was that recommended standardized alcohol screening and diagnostic tools (AUDIT, TLFB, and DSM IV) were used insufficiently in research, which impacts negatively on the comparability of research findings (Chapter 3).

My PhD work looked at the performance of commonly used tools to assess alcohol use and alcohol use disorders. The alcohol screening tools that were evaluated in this research include, the one-month TLFB and the AUDIT and proved to be sensitive measures of self-reported alcohol use among young people in our setting when compared with the biomarker PEth (Chapter 5). Unfortunately, a tool that is commonly used to diagnose alcohol dependence, the MINI (DSM IV), did not perform satisfactorily suggesting that revisions are required to improve its sensitivity and specificity in the diagnosis of alcohol dependence among young people, or that the PEth assay may have limitations that potentially limit its use for the validation of the MINI (Chapter 6) as discussed below.

When applying TLFB and AUDIT we also used pictorial displays and a list of types of alcoholic drinks and their total alcohol concentration to improve the accuracy of estimates of the total amount of alcohol consumed. This allowed us to overcome the information gap resulting from the lack of number of standard drinks per container, particularly for locally available industrial and traditional brands, as is common on our setting. Based on this experience we recommend the use of pictorial displays for similar settings in conjunction with both the TLFB and AUDIT. Together, these tools will be useful for future epidemiological studies and for the evaluation of alcohol interventions among young people in sub-Saharan Africa.

The lack of sensitivity and specificity of the MINI (DSM IV) in diagnosing alcohol dependence among young people in northern Tanzania settings is a matter of concern. Our observations are in line with those of others [8-10]. The lack of specificity is mostly due to the two MINI questions related to alcohol tolerance and compulsion to drink. The revised version of the DSM-IV (DSM-5) still includes these two questions implying that

alcohol dependence diagnosis among young people to date remains a challenge. In chapter 6, these challenges are described and potential ways identified to improve the validity of the MINI (DSM IV) tool. The paper proposes to either remove the two unspecific questions and use a cut-off score of at least 3 "Yes" responses to the remaining five dependence questions, or to keep the questions but raise the cut-off to at least 5 "Yes" responses to all seven dependence questions. However, whilst these two approaches both increased the specificity of the MINI, the sensitivity was still unsatisfactory. Another possible option to improve both sensitivity and specificity of the MINI may be to revise the questions altogether in order to increase their validity for the detection of alcohol dependence in young people. This would require further research. Further research is also needed to find out to what extent alcohol dependence has already become a problem in this age group in East Africa. Such work will probably require joint efforts involving several disciplines including epidemiology, psychiatry and developmental psychology.

Although the TLFB and AUDIT proved to be sensitive measures of alcohol use in a general population, they should be used with caution in settings where alcohol use is likely to be under-reported for example, in the context of individual health care or of legal matters.

We used the biomarker PEth to validate tools that are based on self-reports. However, this has its own limitations. PEth is an indicator of prolonged excessive alcohol use over the last 4 weeks or so. Moderate occasional use, or intake that occurred several weeks ago (episodic drinking with longer intervals), may result in low or undetectable PEth levels (the half-life for PEth in blood is about 4-5 days), and this may lead to misclassification. Also, the metabolism of PEth shows high inter-individual variation, and again this may lead to potential misclassification, e.g. if PEth is metabolised very quickly or very slowly,

leading to an under- or over-diagnosis of heavy alcohol use. Moreover, PEth is not an ideal tool to validate the MINI, as even high PEth assay results cannot reliably predict alcohol dependence in young people, as these may have just recently started to drink heavily. In such cases, a high PEth level may indicate alcohol misuse rather than a level of AUD that has resulted in alcohol dependence. This may explain the seeming lack of sensitivity in the validation study when participants with proven high levels of alcohol intake as evidenced by PEth denied symptoms that would suggest dependence (Chapter 6).

A need for targeted alcohol interventions

Both the systematic review and the survey underscore the need for interventions to reduce hazardous and harmful alcohol use among groups in whom alcohol use is common. Only few studies have been conducted to identify and evaluate interventions against alcohol use and AUD with a focus on young people [11]. Young people in many sub Saharan African countries are vulnerable to HIV infection, given the existing high prevalence of HIV infection and of other adverse outcomes of risky sexual behaviours such as early pregnancy and violence [1,2,12]. Alcohol use increases this vulnerability further for a number of reasons: apart from disinhibition, it is difficult to make use of barrier methods such as condoms correctly and consistently under the influence of alcohol [13]. Also, because the risk of acquisition of other sexually transmitted infections (STIs) is higher under the influence of alcohol, and because other STIs enhance HIV transmission for biological reasons, the detrimental effect of alcohol on HIV infection is likely to be reinforced [4,14]. For these reasons, any targeted alcohol intervention should be combined with efforts to reduce risky sexual behaviour. Vice versa, HIV/STI control programmes for young people should include an alcohol intervention component. Interventions to reduce substance use among adolescent were found to be effective

when administered early, individually and in multiple sessions [15]. The cross-sectional survey highlighted both individual and societal/structural drivers of alcohol use implying that potential interventions may need to combine individual and structural interventions. Structural and societal drivers include for example drinking culture (a permissive norm as we found it in Kilimanjaro Region), easy availability of alcohol, and an abundance of partly aggressive alcohol advertisements that young people in Tanzania are exposed to as the survey also showed. Individual interventions could include alcohol screening followed by brief motivational interviewing that has been found effective in other settings [16,17] . A few brief alcohol intervention projects have been conducted in Africa including among female sex workers in Kenya, university students and patients in South Africa with positive outcome on alcohol consumption reduction [17-20].

Structural interventions may include enforcing legislation on selling alcohol to young people, prohibition of packaging of alcohol in small sachets, and an increase in alcohol price [21,22]. Such interventions have been recommended in some industrialized countries [23], but have not been tried in Africa yet. Particularly for individual interventions, there is a need to adapt these interventions to the East African context by evaluating the delivery strategies and their feasibility.

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Chapter 8. Conclusion and recommendations

Findings from this PhD research indicates that there is a need for urgent interventions to address harmful and hazardous alcohol use among young people in East Africa including Tanzania and probably elsewhere in sub Saharan Africa. These interventions will need to make use of standard diagnostic tools to identify those at need, and the research showed that TLFB and AUDIT are suitable to detect those who require such help. With respect to the risk groups that interventions should focus on college students and casual labourers must be included, in addition to other groups of young people that are known to be at risk, such as sex workers and men who have sex with men.

Due to the close association of alcohol use with risky sexual behaviours, accidents, injuries, and violence, potential alcohol interventions should not only aim at a reduction of alcohol use among young people per se, but address these negative consequences as well. Importantly, there is a need to evaluate the delivery strategies and feasibility of potential interventions to address harmful/hazardous alcohol use in sub Saharan Africa contexts. Alcohol interventions should aim to address both individual factors (harmful and hazardous alcohol use) for example, through brief alcohol screening followed by motivational interviewing, and structural level factors (alcohol availability, alcohol advertisements) using a multi-sectoral response involving the education and health sectors, but also tax regulation and changes in legislation in countries of sub-Saharan Africa.

Appendix 1. Systematic review and meta-analysis detailed search strategies

	MEDLINE database	
	Search terms (text words and subject headings)	**Citations retrieved**
1	exp Alcohol Drinking/ae, ep, mo, pc, px [Adverse Effects, Epidemiology, Mortality, Prevention & Control, Psychology]	26465
2	alcohol abuse.mp. or exp Alcoholism/	71593
3	alcohol$.mp.	281211
4	exp alcohol-related disorders/ or exp alcohol-induced disorders/ or exp alcoholic intoxication/ or exp alcoholism/	95482
5	youth$.mp. or exp Adolescent/	1580841
6	Adolescent/ or teenage$.mp.	1573769
7	(adolescent or child or student).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	2494555
8	persons/ or age groups/ or adolescent/ or young adult/	1712711
9	africa.mp. or exp Africa/	198423
10	Tanzania.mp. or exp Tanzania/	8583
11	Kenya.mp. or exp Kenya/	13071
12	Somaliland.mp.	76
13	Uganda.mp. or exp Uganda/	8859
14	Burundi.mp. or exp Burundi/	611
15	Rwanda.mp. or exp Rwanda/	1657

16	Eritrea.mp. or exp Eritrea/	312
17	Ethiopia.mp. or exp Ethiopia/	7317
18	Djibouti.mp. or exp Djibouti/	261
19	Somalia.mp. or exp Somalia/	1425
20	Seychelles.mp. or exp Seychelles/	479
21	South-Sudan.mp.	117
22	Comoros.mp. or exp Comoros/	299
23	1 or 2 or 3 or 4	282093
24	5 or 6 or 7 or 8	2634394
25	9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22	202327
26	23 and 24	48829
27	25 and 26	1235

	EMBASE database	
	Search terms (text words and subject headings)	**Citations retrieved**
1	exp drinking behavior/co, ep [Complication, Epidemiology]	3267
2	alcoholism.mp. or exp alcoholism/	113395
3	exp alcohol abuse/	20973
4	alcohol drinking.mp. or exp drinking behavior/	36967
5	alcohol/ or alcohol consumption/ or alcoholism/	307569
6	alcohol consumption/ or drunk$.mp. or alcohol/ or alcoholism/ or drunkenness/ or alcohol intoxication/	315047
7	(adolescent or child or student).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	2652116
8	exp juvenile/ or adolescent/	1263951
9	youth$.mp.	47218
10	(young adj2 people).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	21808
11	(early adj2 adult$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	6646
12	(young adj2 adult$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	75907
13	teenage$.mp. or exp adolescence/	86727
14	exp Africa/ or africa.mp.	239298
15	Tanzania.mp. or exp Tanzania/	10057
16	Kenya.mp. or exp Kenya/	14834
17	Somaliland.mp.	150
18	Uganda.mp. or exp Uganda/	11677
19	Burundi.mp. or exp Burundi/	701
20	Rwanda.mp. or exp Rwanda/	1940
21	Eritrea.mp. or exp Eritrea/	455

22	Ethiopia.mp. or exp Ethiopia/	8375
23	Djibouti.mp. or exp Djibouti/	342
24	Somalia.mp. or exp Somalia/	1617
25	Seychelles.mp. or exp Seychelles/	566
26	South-Sudan.mp.	150
27	Comoros.mp. or exp Comoros/	309
28	1 or 2 or 4 or 5 or 6	344799
29	7 or 8 or 9 or 10 or 11 or 12 or 13	2748730
30	14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27	244768
31	28 and 29	42424
32	30 and 31	835

	PsycINFO database	
	Search terms (text words and subject headings)	**Citations retrieved**
1	exp drinking behavior/ [Complication, Epidemiology]	55829
2	alcoholism.mp. or exp alcoholism/	32794
3	exp alcohol abuse/	37188
4	alcohol drinking.mp. or exp drinking behavior/	56991
5	alcohol/ or alcohol consumption/ or alcoholism/	24035
6	alcohol consumption/ or drunk$.mp. or alcohol/ or alcoholism/ or drunkenness/ or alcohol intoxication/	28229
7	(adolescent or child or student).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	444202
8	youth$.mp.	60262
9	(young adj2 people).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	16285
10	(early adj2 adult$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	3689

11	(young adj2 adult$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	29706
12	teenage$.mp.	10139
13	exp Africa/ or africa.mp.	13495
14	Tanzania.mp. or exp Tanzania/	1127
15	Kenya.mp. or exp Kenya/	1798
16	Somaliland.mp.	11
17	Uganda.mp. or exp Uganda/	1455
18	Burundi.mp. or exp Burundi/	69
19	Rwanda.mp. or exp Rwanda/	479
20	Eritrea.mp. or exp Eritrea/	76
21	Ethiopia.mp. or exp Ethiopia/	758
22	Djibouti.mp. or exp Djibouti/	10
23	Somalia.mp. or exp Somalia/	214
24	Seychelles.mp. or exp Seychelles/	36
25	South-Sudan.mp.	16
26	Comoros.mp. or exp Comoros/	5
27	1 or 2 or 3 or 5 or 6	63552
28	7 or 8 or 9 or 10 or 11 or 12	507329
29	13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26	18024
30	27 and 28	10307
31	29 and 30	49

	GLOBAL HEALTH database	
	Search terms (text words and subject headings)	**Citations retrieved**
1	drinking behavior.mp. or alcoholism.sh. or behaviour.sh. or alcohol intake.sh. or alcoholic beverages.sh.	64697
2	exp alcoholism/ or addiction/ or alcoholic beverages/	14438

3	alcohol abuse.mp. or drug users.sh. or alcohol intake.sh. or alcoholism.sh. or substance abuse.sh. or drug abuse.sh. or alcoholic beverages.sh.	32358
4	alcohol drinking.mp. or alcohol intake.sh. or alcoholic beverages.sh. or drinking.sh. or alcohols.sh. or alcoholism.sh.	27779
5	alcohol/ or alcohol consumption/ or alcoholism/	19164
6	alcohol consumption/ or drunk$.mp. or alcohol/ or alcoholism/ or drunkenness/ or alcohol intoxication/	20623
7	alcohol consumption.mp. or exp alcohol intake/	17689
8	exp adolescents/ or school children/ or young adults/	53213
9	(adolescent or child or student).mp. [mp=abstract, title, original title, broad terms, heading words]	79179
10	juvenile .mp. or adolescent.mp.	18875
11	youth$.mp. or exp youth/	13275
12	(young adj2 people).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	4919
13	(early adj2 adult$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	1117
14	(young adj2 adult$).mp. [mp=abstract, title, original title, broad terms, heading words]	15404
15	teenage$.mp. or exp adolescence/	33844
16	exp Africa/ or africa.mp.	177386
17	Tanzania.mp. or exp Tanzania/	9516
18	Kenya.mp. or exp Kenya/	12567
19	Somaliland.mp.	352
20	Uganda.mp. or exp Uganda/	8962
21	Burundi.mp. or exp Burundi/	601

22	Rwanda.mp. or exp Rwanda/	1318
23	Eritrea.mp. or exp Eritrea/	573
24	Ethiopia.mp. or exp Ethiopia/	6801
25	Djibouti.mp. or exp Djibouti/	300
26	Somalia.mp. or exp Somalia/	1458
27	Seychelles.mp. or exp Seychelles/	295
28	South-Sudan.mp.	117
29	Comoros.mp. or exp Comoros/	267
30	1 or 2 or 3 or 4 or 5 or 6 or 7	80444
31	8 or 9 or 10 or 11 or 12 or 13 or 14 or 15	138201
32	16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29	178733
33	30 and 31	13508
34	32 and 33	920

	AFRICAWIDE INFORMATION database	
	Search terms (text words and subject headings)	**Citations retrieved**
1	alcohol-drinking	1599
2	alcohol-abuse	2469

3	drug-abuse	3036
4	alcoholism*	9922
5	alcohol-consumption	1580
6	Alcohol and college	528
7	Drug addiction	2789
8	Adolescent	111166
9	Students	40504
10	Young-adults	26100
11	young-people	5087
12	alcohol-beverages	21
13	alcoholic	3730
14	youths	28174
15	young N2 people	5245
16	young N2 adults	26604
17	Africa	1693539
18	Tanzania	41493
19	Kenya	79650
20	Somaliland	2355
21	Uganda	48702
22	Burundi	15167
23	Rwanda	17680
24	Eritrea	6647
25	Ethiopia	42965
26	Djibouti	4111
27	Somalia	23560
28	Seychelles	3199
29	South-Sudan	2354
30	Comoros	2685
31	1 or 2 or 3 or 4 or 5 or 6 or7 or 12 or 13	18298

32	8 or 9 or10 or11 or14 or 15 or 16	184589
33	17 or 18 or 19 or 20 or 21 or 22 or24 or 25 or 26 or 27 or 28 or 29 or 30	1780419
34	31 and 32 and 33	974

Appendix 2. Survey questionnaire and additional information to determine total alcohol intake in a drinking event

SECTION 1: SOCIO-DEMOGRAPHIC INFORMATION

We begin this interview by asking you to provide basis information about yourself. This information is important and you are requested to provide as much details as possible.

QNo	Code	Questions and Filters	Coding Categories	Programming notes
101	Intdate	*Write date of interview*	|__|__| |__|__|__| |__|__|__|__| Day Month Year	
102a	Location	Location	Moshi Urban 1 Moshi Rural 2 Nyamagana 3 Sengerema 4	
102b	Locationot		Other 5 (Specify)……	
103a	Group	Study group	Secondary school student 1 College student 2 university student 3 Employed in soft drink industry 4 Employed in a farm 5 Employed in a ginnery 6 Out of school-unstable employment 7 Other industry 8	
103b	Groupother		(Specify)……	
104	Sex	What is your gender?	Male 1	

			Female 2	
105	Dob	What is your date of birth?	|__|__| |__|__|__| |__|__|__|__| Day Month Year ***write 99 for day or 999 for month or 9999 for year if unknown***	
106	Age	How old are you?	|__|__| Write completed years	
107a	Religion	What is your religion?	Muslim 1 Roman Catholic 2 Africa Inland Church 3 Pentecostal 4 Lutheran 5 Other 6	
107b	Religionot		(Specify)…….……..	
108a	Tribe	What is your tribe?	Sukuma 1 Nyamwezi 2 Mkurya 3 Chagga 4 Pare 5 Haya 6 Other 7	
108b	Tribeot		(Specify)…….……..	
109	Educat	What is the highest level of formal education you have completed?	Never went to school 1 Incomplete primary school 2 Complete primary school 3 Secondary (form one-four) 4 Secondary (form one-six) 5 University/ college 6	

110	Maristat	Currently, what is your marital status?	Single 1 Single (with boyfriend/girlfriend) 2 Cohabiting 3 Married 4 Separated/divorced 5 Widowed 6	
111	Income	<u>On average</u>, how much money do you have available each month through either your job or your family support?	TZS|__|__|__|__|__|__||__| ***(write 9999999 if don't know)***	
112a 112b	Live liveother	Currently, where do you live?	I live at home with both parents 1 I live at home with one parent 2 I live at home with a relative/guardian 3 I live at home with my partner 4 I live at boarding school 5 I live in a hostel/rented room 6 I live in a rented apartment 7 Other 8 (Specify)……..	
113	Pareducat	What is the highest level of education of the persons with whom you live?	Never went to school 1 Incomplete primary school 2 Complete primary school 3 Secondary (form one-four) 4 Secondary (form one-six) 5 University/ college 6 Unknown 7 Not applicable 8	

SECTION 2: ALCOHOL USE

In this section, we are going to ask you questions related to alcohol use. As you know there are many alcoholic drinks in the community and some people drink alcohol regularly. We would like to find out young people experiences with alcohol in this community. This information will remain confidential and will not be shared with other people. We are not here to judge you as a person but rather to gain understanding of a number of issues related to alcohol use among young people in this community. Remember we have not written your name on this form and this information will not be directly linked to you.

201	alcoh1	In what year did you have your first alcoholic drink?	|__|__|__|__| Year ***write 9999 if unknown*** ***write 0000 if never used alcohol***	If never used alcohol skip to Q206
202	alcoh2	How old were you when you had your first alcoholic drink?	|__|__| Years ***write 99 if unknown***	
203a	Alcoh3	At what occasion did you have your first alcoholic drink?	Holiday 1 Wedding ceremony 2 School party/graduation 3 At a part with friends 4 Other family cerebration 5 Other 6	
203b	Alcoh3ot		(specify)……..	
204a		What type of alcoholic drink did you drink?	No Yes	
	Alcoh4a		Bottled beer 1 2	
	Alcoh4b		Wine 1 2	
	Alcoh4c		Spirit/liquor 1 2	
	Alcoh4d		Local beer/spirit/liquor 1 2	
	Alcoh4e		Other 1 2	
204b	Alcoh4eot		(Specify) …….	
205a		What were the reasons for drinking?	No Yes	After this question skip to Q207
	Alcoh5a	I wanted to try it	1 2	
	Alcoh5b	My friends convinced me	1 2	
	Alcoh5c	My parents/relatives advice me	1 2	
	Alcoh5d	My partner convinced me	1 2	

	Alcoh5e	Other	1 2	
205b	Alcoh5eot	(specify)……		
206a		What are the reasons for not starting/trying an alcoholic drink?	No Yes	After this question skip to Q301
	Alcoh6a		1 2	
	Alcoh6b	My parents are against alcohol	1 2	
	Alcoh6c	Relatives are against alcohol	1 2	
	Alcoh6d	My religion is against alcohol	1 2	
	Alcoh6e	My friends are against alcohol	1 2	
	Alcoh6f	I am afraid of alcohol side effects	1 2	
	Alcoh6fg	Other	1 2	
	Alcoh6fot			
206b		(Specify)……		
207	Alcoh7	In the past 12 months, have you ever drunk any alcohol?	No 1 Yes 2	If yes skip to Q209
208a		What are the reasons you didn't drink alcohol in the past 12 months?	No Yes	After this question skip to Q301
		My parents are against alcohol		
	Alcoh8a	Relatives are against alcohol	1 2	
	Alcoh8b	My religion is against alcohol	1 2	
	Alcoh8c	I have no money	1 2	
	Alcoh8d	I don't like alcohol	1 2	
	Alcoh8e	I'm home and not possible	1 2	
	Alcoh8f	I'm at college and not possible	1 2	
	Alcoh8g	I have health problems	1 2	
	Alcoh8h	Other	1 2	
	Alcoh8i	(Specify)……	1 2	
208b	Alcoh8ot			

209a 209b	 Alcoh9a Alcoh9b Alcoh9c Alcoh9d Alcoh9e Alcoh9eot	What type of alcohol do you <u>usually drink</u>? Bottled beer Wine Spirit/liquor Local beer/spirit/liquor Other (Specify) ……	No Yes 1 2 1 2 1 2 1 2 1 2	
210	Alcoh10	<u>On average</u>, how many days in a week do you drink alcohol?	Number of days per week |___| ***(write 0 if none)(write 8 if do not drink on weekly basis)*** ***(write 9 if unknown)***	
211 212	Alcoh11 Alcoh12 Audit1	<u>On average</u>, how many drinks do you have on a typical day when you are drinking? How often do you have a drink containing alcohol?	Indicate type of container used (e.g. beer bottles, glass of wine etc) …… Amount of beverage |__|__| Never 0 Monthly or less 1 2-4 times a month 2 2-3 times a week 3 4 or more times a week 4	
213 214	Audit2 Audit3	How many standard drinks do you have on a typical day when drinking? How often do you have six or more drinks on one occasion?	1 or 2 0 3 or 4 1 5 or 6 2 7 or 9 3 10 or more 4 Never 0 Less than monthly 1	

			Monthly 2 Weekly 3 Daily or almost daily 4	
215	Audit4	How often during the last year have you found that you were not able to stop drinking once you had started?	Never 0 Less than monthly 1 Monthly 2 Weekly 3 Daily or almost daily 4	
216	Audit5	How often during the last year have you failed to do what was normally expected of you because of drinking?	Never 0 Less than monthly 1 Monthly 2 Weekly 3 Daily or almost daily 4	
217	Audit6	How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?	Never 0 Less than monthly 1 Monthly 2 Weekly 3 Daily or almost daily 4	
218	Audit7	How often during the last year have you had a feeling of guilt or remorse after drinking?	Never 0 Less than monthly 1 Monthly 2 Weekly 3 Daily or almost daily 4	
219	Audit8	How often during the last year have you been unable to remember what happened the night before because of your drinking?	Never 0 Less than monthly 1 Monthly 2 Weekly 3 Daily or almost daily 4	

220	Audit9	Have you or someone else been injured because of your drinking?	No 0 Yes, but not in the last year 2 Yes, during the last year 4	
221	Audit10	Has a relative, friend, doctor, or other health care worker been concerned about your drinking or suggested you cut down?	No 0 Yes, but not in the last year 2 Yes, during the last year 4	
222	dsm1	Have you ever failed to fulfill major role obligations at work, school, or home (e.g., repeated absences or poor work performance related to substance use; substance-related absences, suspensions or expulsions from school; or neglect of children or household)?	No 1 Yes, but not in the last year 2 Yes, during the last year 3	
223	dsm2	Do you drink when working, driving, or operating heavy machinery?	No 1 Yes, but not in the last year 2 Yes, during the last year 3	
224	dsm3	Have you ever gotten trouble with any authorities because you drank too much? (e.g. problems with school authorities, police etc)	No 1 Yes, but not in the last year 2 Yes, during the last year 3	
225	dsm4	Have you ever continued to drink alcohol despite persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the alcohol (e.g., arguments with spouse about consequences of intoxication or physical fights).	No 1 Yes, but not in the last year 2 Yes, during the last year 3	
226	dsm5	Have you ever felt a need to increase the amount of alcohol that you drink to achieve the desired effect which was initially attained by lesser amount of alcohol (few drinks)	No 1 Yes, but not in the last year 2 Yes, during the last year 3	
227	dsm6	Have you ever experienced a feeling of nervousness, feeling of shakiness, anxiety, irritability or easily excited, emotional volatility, rapid emotional changes and excessive sweating	No 1 Yes, but not in the last year 2 Yes, during the last year 3	

228	dsm7	Do you take alcohol (drug-valium) to get relief from the above experiences taking alcohol or valium?	No 1 Yes, but not in the last year 2 Yes, during the last year 3	
229	dsm8	Do you often consume alcohol in larger amounts over a longer period than was intended	No 1 Yes, but not in the last year 2 Yes, during the last year 3	
230	dsm9	Do you have a persistent desire or there are unsuccessful efforts to cut down or control alcohol use	No 1 Yes, but not in the last year 2 Yes, during the last year 3	
231	dsm10	Have ever felt that you spend a great deal of your time in activities necessary to obtain alcohol, use alcohol or recover from its effects	No 1 Yes, but not in the last year 2 Yes, during the last year 3	
232	dsm11	Have you reduced important social, occupational, or recreational activities are given up or reduced because of alcohol use	No 1 Yes, but not in the last year 2 Yes, during the last year 3	

SECTION 3: ALCOHOL ADDITIONAL INFORMATION

Thank you for providing responses to the alcohol questions so far this is highly appreciated. We have another set of questions to collect additional information related to alcohol. Please take a few minutes to complete this part. Your responses are very important and we hope to learn a lot from this information.

301	Advert1	During the past 30 days, how often did you see any alcohol advertisements?	Never 1 Rarely 2 Sometimes 3 Almost daily 4 Daily 5	
302	binge	During the past 30 days, how many times did you drink so much alcohol that you were really drunk?	0 times 1 1 or 2 times 2 3 to 9 times 3 10 or more times 4 Not applicable 5	
303	cost	During the past 30 days, how much of your money did you spend on alcohol drinks?	None 1 Less than Tshs 5000 2 Between Tshs 5,000-10000 3 More than Tshs 10,000 4 Not applicable 5	
304	costb	During the past 30 days, how much money was spent on alcohol, by others, offering you drinks?	None 1 Less than Tshs 5000 2 Between Tshs 5,000-10000 3 More than Tshs 10,000 4 Not applicable 5	
305	compl	During the past 30 days, how many times did you get into trouble with your family or friends, miss school, or get into fights as a result of drinking alcohol?	0 times 1 1 or 2 times 2 3 to 9 times 3 10 or more times 4 Not applicable 5	

306	whom	With whom do you usually drink alcohol?	With my friends 1 With my family 2 With persons I have just met 3 I usually drink alone 4 Not applicable 5	
307	relat	Do any of your brothers or sisters drink alcohol?	I do not have brothers/sisters 1 Yes 2 No 3 I do not know 4	
308	Influad1	When you watch television, videos, or movies, how often do you see actors drinking alcohol?	I do not watch TV, videos, or movies 1 Never 2 Rarely 3 Sometimes 4 Most of the time 5 Always 6	
309	Influad2	When you go to sports events, fairs, concerts, community events, or social gatherings how often do you see advertisements for alcohol?	I do not go to these events 1 Never 2 Rarely 3 Sometimes 4 Most of the time 5 Always 6	
310	Influad8	If one of your best friends offered you a drink of alcohol, would you drink it?	Definitely not 1 Probably not 2 Probably yes 3 Definitely yes 4	

311	availab	How difficult do you think it would be for you to get alcohol, such as beer or wine? If you wanted to?	Impossible 1 Very difficult 2 Fairly difficult 3 Fairly easy 4 Very easy 5 I do not know 6	
312	Curric1	During the school years, were you taught in any of your classes about the problems associated with drinking alcohol?	No 1 Yes 2 I do not know 3	
313	Curric2	During the school years, were you taught in any of your classes about the effects of alcohol use on decision-making?	No 1 Yes 2 I do not know 3	
314	Curric3	During the school years, were you taught in any of your classes about how to tell someone you did not want to drink alcohol?	No 1 Yes 2 I do not know 3	
315	Harma	Do you think that alcohol drinking may be harmful?	No 1 Yes 2 I do not know 3	*If the answer is No or I do not know skip to Q317*

316a

SECTION 4: Tobacco and other Drugs use

I am now going to ask you about your experience in using tobacco and other drugs. These questions are important and we request you to respond as accurately as possible. Remember we are not here to judge you as a person. This information will remain confidential and will not be shared with other people.

QNo	Code	Questions and Filters	Coding Categories			Programming notes
401	tobdru1	Have you ever used any tobacco products in your life?	No Yes	1 2		If No skip to Q405
402	tobdru2	Do you currently use any tobacco products?	No Yes	1 2		If NO skip to Q405
403	tobdru3	Do you currently use tobacco products daily? (i.e., almost every day for at least one year)	No Yes	1 2		
404	tobdru4	How old were you when you first started smoking daily*? (Probe age in years)*	|__|__|Years ***Write 99 if don't know***			
405	tobdru5	Have you ever smoked or used any drugs/substance in your life?		1 2		If No skip to Q501
406a		Which of these drugs/substances have you ever used?		No	Yes	
	tobdru6a		Marijuana	1	2	
	tobdru6b		Heroin	1	2	
	tobdru6c		Cocaine	1	2	
	tobdru6d		Khat (mirungi)	1	2	
	tobdru6e		Other	1	2	
406b	tobdru6ot		(specify)……			

SECTION 5: Sexual behavior

Thank you for responding to all these questions. This is the last section and I will ask information related to sexual behavior. I understand some of these questions may be sensitive. I request you to respond to as many questions as possible as this will be very helpful for this study.

501	sthiv1	How old were you when you first had sex?	|__|__|Years ***Write 99 if don't know*** ***Write 88 for those who never had sex***	
502	Sthiv2	The last time you had sex, did you or your partner drink alcohol beforehand?	I have never had sex 1 Yes 2 No 3	
503	Sthiv3	The last time you had sex; did you or your partner use drugs beforehand?	I have never had sex 1 Yes 2 No 3	
504	Sthiv4	The last time you had sex, did you or your partner use a condom	I have never had sex 1 Yes 2 No 3	
505	Sthiv5	How often do you or your partner use a condom when you have sex?	I have never used condom 1 Rarely 2 Sometimes 3 Most of the time 4 Always 5 I have never had sex Never 6	
506	Sthiv6	How many different sex partners have you ever had?	I have never had sex 1 1 person 2 2 people 3 3 people 4 4 people 5 5 people 6 6 or more people 7	

			I do not remember 8	
507	Sthiv7	Have you ever been told by a doctor or nurse that you had a sexually transmitted infection, such as gonorrhoea, syphilis, HIV?	Yes 1 No 2 I do not know 3	
508	Sthiv8	Have you ever been tested for HIV infection or AIDS?	Yes 1 No 2	
509	Sthiv9	Have you ever experienced vaginal/penile discharge in the past 12 months	Yes 1 No 2 I do not know 3	
510	sthiv10	Have you ever had ulcers in your private parts (genitals) in the past 12 months	Yes 1 No 2 I do not know 3	
511	Sthiv11	In the past 12 months, how many different sex partners have you had?	|__|__|__| partners ***Write 999 if do not remember and 000 if did not sex in the past 12 months and 888 if never had sex***	
512	Sthiv12	In the last 30 days, how many casual sexual partners have had? (Causal partners are any sex partners who are not constant friend or partner; they may include people who you pay for having sex, or not)	None 1 One 2 More than one 3 I have never had sex 4	
513	sthiv13	Have you ever have sex under the influence of alcohol which you regretted the next day?	Yes 1 No 2 Don't remember 3 I have never had sex 4 Not applicable 5	

Thank you for agreeing to participate in this study. I know this has taken a long time to finish. I know your participation have contributed to the success of this study. Let me know if you have any final questions or need any information related to the questions you were asked.

Data Reviewer	
Date	

	ENTRY 1	ENTRY 2
Initials		
Date		

Appendix3. Pictorial display of beers with standard drinks

LOCALLY AVAILABLE INDUSTRIAL MADE BEERS IN MWANZA, TANZANIA

Alcohol concentration expressed as Alcohol concentration by volume (ABV)

Kilimanjaro Premium Lager, 4.5% ABV, 500ml (2 standard drinks)	Serengeti Premium Lager, 4.8% ABV, 500ml (2 standard drinks)	Safari Lager, 5.5% ABV, 500ml (3 standard drinks)

Uhuru Peak Lager, 5.5% ABV, 500ml (3 standard drinks)	Senator Extra Lager, 6.0% ABV, 500ml (3 standard drinks)	Kilimanjaro Premium Lager, 4.5% ABV, 330ml (1 standard drink)

Appendix 4. Additional information to determine total amount of alcohol intake in each drinking event as identified in the TFLB

Study ID: |___|___|___|___|___| **Event Number:|___|___|**

Thank you for agreeing to participate in our study and responding to earlier questions regarding alcohol use. I will now ask you some more question with the aim of describing further a particular drinking event.

QNo.	Questions and Filters	Coding Categories				Codes & skip instructions
101	Write interviewer's code or initials	INTERVIEWERCODE/ INITIALS [____|____]				staffenrq
102	Write date of interview	|__|__| |__|__|__| |__|__|__|__| DAY MONTH YEAR				dateenrol
103	Write date of the drinking event	|__|__| |__|__|__| |__|__|__|__| DAY MONTH YEAR				dateevent
	Drink name	Volume of the bottle/can	Number of bottles	Number of drinks	How many people shared the drink	
104a						drink1
104b						drink2
104c						drink 3
104d						drink 4

Appendix 5. Mini international neuropsychiatric interview (MINI)

English Version 6.0.0 - DSM-IV

USA: D. Sheehan[1], J. Janavs, K. Harnett-Sheehan, M. Sheehan, C. Gray.

[1]University of South Florida College of Medicine- Tampa, USA

EU: Y. Lecrubier[2], E. Weiller, T. Hergueta, C. Allgulander, N. Kadri, D. Baldwin, C. Even.

[2]Centre Hospitalier Sainte-Anne – Paris, France

Section I. ALCOHOL ABUSE AND DEPENDENCE

Section I2 Alcohol dependence

In the past 12 months:

a	Did you need to drink more in order to get the same effect that you got when you first started drinking?	**YES NO**
b	When you cut down on drinking did your hands shake, did you sweat or feel agitated? Did you drink to avoid these symptoms or to avoid being hungover, for example, "the shakes", sweating or agitation? IF **YES** TO EITHER, CODE **YES**.	**YES NO**
c	During the times when you drank alcohol, did you end up drinking more than you planned when you started?	**YES NO**
d	Have you tried to reduce or stop drinking alcohol but failed?	**YES NO**
e	On the days that you drank, did you spend substantial time in obtaining alcohol, drinking, or in recovering from the effects of alcohol?	**YES NO**
f	Did you spend less time working, enjoying hobbies, or being with others because of your drinking?	**YES NO**
g	Have you continued to drink even though you knew that the drinking caused you health or mental problems?	**YES NO**

ARE **3** OR MORE **I2** ANSWERS CODED **YES**?
If Yes: ***CURRENT ALCOHOL DEPENDENCE***